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The Blast Furnace and Steel Plant

VOL. VIII. PITTSBURGH, PA, AUGUST, 1920. No. 8

Babbitts and Babbitting in Steel Plants

Description of the Process of Babbitting Bearings as Developed by the Westinghouse Company After Many Years of Experiments —Suitable With Either Lead Base Babbitt or Tin Base Babbitt.

By T. D. LYNCH,

Research Engineer, Westinghouse Electric & Manufacturing Company.

A LITTLE more than 80 years ago, Isaac Babbitt, a goldsmith, of Tanton, Mass., patented the then novel idea of using a soft lining metal in journal boxes, and holding it in place by proper anchorage. The best formula for this lining metal was not settled by Mr. Babbitt nor has it yet been settled by later students of this subject.

Some authorities state that the formula used by him was: 88.9 Sn., 7.4 Sb., 3.7 Cu. The formulas in general and special use today, however, are so numerous and so varied that we cannot pick out a tin base nor a lead base alloy that may be considered as an American standard.

In 1918, Committee B-2 of the American Society for Testing Materials, made an attemp to at least tabulate the most practical compositions for tin base and lead base lining metals for bearings, and the result of a compromise of the members of this committee is given in Table 1, which gives the alloy numbers, together with their corresponding compositions. Grades 1 to 5 are of the tin base group and grades seven to 12 are of the lead base group. No standard composition could be agreed upon for either group and I venture to say that the greater tonnage of bearing babbitts smelted during the past year does not correspond to any one of the 12 alloys selected by this committee.

Table 1.

A. S. T. M. Babbitts Specification B 23-18 T.

Alloy Grade No.	Tin, per cent	Antimony, per cent	Lead, per cent	Copper, per cent	Iron, per cent max.	Arsenic, per cent max.	Zinc, per cent	Aluminum, per cent
1	91	4½	0.35a	4½	0.08	0.10	none	none
2	89	7½	0.35a	3½	0.08	0.10	none	none
3	83 1/3	8 1/3	0.35a	8 1/3	0.08	0.10	none	none
4	75	12	10	3	0.08	0.15	none	none
5	65	15	18	2	0.08	0.15	none	none
6	20	15	63½	1½	0.08	0.15	none	none
7	10	15	75	0.50a	...	0.20	none	none
8	5	15	80	0.50a	...	0.20	none	none
9	5	10	85	0.50a	...	0.20	none	none
10	2	15	83	0.50a	...	0.20	none	none
11	..	15	85	0.50a	...	0.25	none	none
12	..	10	90	0.50a	...	0.25	none	none

a—Maximum.

Our experience with tin base babbitts has resulted in a selection of a composition between that of numbers two and three, having approximately 10 sb. and 5 cu. — the balance tin.

This metal flows readily into linings 1/16 inch thick and lighter, while a higher copper content, such as number three (a most excellent babbitt) tends to sluggishness when being poured, resulting in the necessity for much thicker linings than 1/16 inch.

Likewise our experience with lead base babbitts has resulted in a selection of a composition between numbers 7 and 8, having approximately 14 sb., 8 sn., with not over 5 per cent cu. and the balance lead, resulting in a metal that flows even more readily than the tin base composition given above and performs well in service. This latter babbitt and its process of manufacture are the results of many years of experimenting and testing, first in the laboratory and finally by the crucial test of practical service application in commercial work. The great expense, constant effort and difficulties involved in this development give us some realization as to why an American standard babbitt metal has not as yet been established.

At least four main reasons suggest themselves for the slow progress made towards the adoption of a standard babbitt—first, the lack of standard methods of physically testing them so as to give comparative results in a reasonably short time. Many tests have been proposed but none as yet has been accepted as standard; second, the general lack of facilities for the proper control of the temperature of the metal in the babbitting pot as well as lack of care of metal to prevent the admixture of other ingredients; third, the varying conditions of service, such as size of bearing, bore allowance pressure, speed, lubrication, constant and intermittent service, surrounding temperature and whether or not subjected to vibration; fourth, cost. The scarcity and relatively high price of tin has made it commercially necessary to study and experiment with lead base metals; especially is this true

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From paper read before Association of Iron and Steel Electrical Engineers.

when the unit pressures are not too great.

In 1903, George H. Clamer presented a paper before Franklin Institute (Journal of Franklin Institute, July-October, 1903) giving a very comprehensive study of alloys suitable for bearing purposes and describing the Carpenter friction testing machine. The W. E. & M. Company purchased a Carpenter testing machine and made tests on lead base versus tin base babbitts. These tests, while on the whole unsatisfactory, showed less friction in the lead base than in the tin base metals. The late Dr. C. B. Dudley, for many years chemist for the Pennsylvania Railroad Company, also tried out the Carpenter and other similar machines but decided that the service test was the only reliable one.

In 1913 the writer presented a paper before the American Society for Testing Materials (Vol. XIII), giving a series of tests on tin base and lead base babbitts, showing the development of the Brinell and Hammer tests, which we have found very useful and which we continue to use at the laboratories of the W. E. & M. Company. We have been agreeably surprised to know that the Brinell test is a good criterion of the proper making of babbitt metal. It must be used, however, in connection with other known facts about the metal, viz.: composition, methods of manufacture, etc., and at best it is only an arbitrary method of testing.

Every kettle of 3,000 pounds of babbitt is given the Brinell test. This test consists of pouring a sample into a metal mold ¾ inch deep by 1⅞ inches diameter at bottom and 2 inch diameter at top. The mold is preheated to approximately 40 degrees C., by pouring preliminary samples to warm up the mold. The Brinell impressions are made on the bottom face of the test piece as cast. This Brinell value for tin base babbitt should be 30 to 38 with average 34½ and for lead base babbitt 25 to 31. When a babbitt shows less than 24 Brinell hardness, trouble is evidenced by the wiping effect observed while the upper limits of Brinell hardness in lead bore babbitts must also be watched to avoid brittleness.

With these introductory remarks, we are going to assume that the bearing is of proper mechanical design to give the necessary support and lubrication requisite for good service, that the babbitt metal is of proper composition, well made and cared for and is now ready for the babbitting process.

Successful babbitting must be thoughtfully and carefully done and we are quite of the opinion that any babbitt can be ruined by improper handling in the babbitting operation. The Westinghouse Company has developed a process suitable for babbitting bearings with their lead base babbitt and which is equally suitable for the tin base babbitt. It is the result of many years development and is now being used for the production of bearings requiring approximately 40 tons of babbitt metal each month. This process is divided into the following sub-headings:

I Preliminary machinery of shells.
II Cleaning of shells.
III Care of tinning alloy.
IV Tinning of bronze shells.
V Tinning of pipe bearing shells.
VI Anchor holes in cast iron and malleable iron shells.
VII Sizes of mandrels.
VIII Preheating of mandrels.
IX Preheating of shells.
X Babbitting.
XI Peening or rolling.
XII Cleaning solutions.
XIII Materials.

I. Preliminary Machining of Shells:

1. Boring of cast iron, malleable iron and bronze shells.

Bore shells to dimensions given on drawings. Care must be observed to see that proper space is left so that the babbitt lining will be of uniform thickness and of the dimensions specified.

2. Preparation of pipe shells.

Select pipe of proper diameter and thickness of section, cut it to the length specified and face off one end so that it will stand parallel with babbitting mandrel to give same thickness of babbitt at all points.

II. Cleaning of Shells:

Clean shells thoroughly from all sand, scale, rust, oil, grease, etc.

Remove sand by sand-blast or by pickling in hydro-fluoric solution.

Remove scale or rust by sand-blast or by pickling in sulphuric acid solution and remove oil or grease by burning it off before pickling in sulphuric acid solution or remove it by dipping in caustic soda solution.

All acid dips must be followed immediately with thorough washing in clean water.

III. Care of Tinning Alloy:

Melt alloy No. 19 in an iron or steel pot, maintain the temperature of the metal in the pot between 410 degrees C. and 440 degrees C. The tinning alloy should not be heated above 450 degrees C.

If the pot is used only occasionally, cover the melted alloy with saw dust or charcoal to prevent the formation of dross.

The metal must be stirred frequently when being used and always before using after standing for any length of time in molten condition.

IV. Tinning of Bronze Shells:

1. Bronze shells that are to be babbitted.

This tinning operation consists in coating the surface to be babbitted with a thin coat of alloy No. 19. Coat the machined parts that are not to be tinned with a thin mixture of graphite and water. When dry, swab parts to be tinned with zinc chloride, then dip into a pot of No. 19 alloy maintained at a temperature between 410 degrees and 440 degrees C. Leave the shell in the pot until it is just hot enough for the No. 19 alloy to run off. Remove the shell from the pot and thoroughly rub the surface to be tinned with zinc chloride, making sure that all parts have a thin coating of the alloy and that no untinned spots are left on the surface to be babbitted. Immerse the shell again in the No. 19 alloy to remove the acid left from the swab and do not swab or otherwise touch the tinned surface again but babbitt immediately.

2. Bronze shells that are not to be babbitted.

Coat parts not to be tinned with a thin mixture of graphite and water. When dry, swab parts to be tinned with chloride, then dip into a pot of No. 19 alloy maintained at a temperature between 410 degrees and 440 degrees C. Leave the shell in the pot until it is just hot enough for the No. 19 alloy to run off. Remove the shell from the pot and thoroughly rub the surface to be tinned with a swab saturated with zinc chloride, making sure that all parts have a thin coating of the alloy and that no untinned spots are left. Immerse the shell again in the No. 19 alloy to remove the acid left from the swab, after which clean with waste to remove any oxide or other foreign matter and brush the graphite from the untinned parts.

V. Tinning of Pipe Bearing Shells:

Pickle the shells made from steel pipe in sulphuric acid solution for one to two hours, or until free from rust and scale, wash immediately in clean water, then dip into zinc chloride and finally into a pot of alloy No. 19, maintained at a temperature of 410 degrees C. to 440 degrees C., until the shell comes to the temperature of this alloy, remove the shell from the pot, brush off the excess alloy and cool in water.

Coat the outside of shell with a red clay wash, again dip the shell into alloy No. 19 until it comes to approximately the temperature of the alloy, remove it from pot and swab the bore with zinc chloride, dip again in alloy No. 19, do not swab or otherwise touch the tinned surface but babbitt immediately.

VI. Anchor Holes in Cast Iron and Melleable Iron Shells:

All anchor holes should be cleaned well so that the babbitt is held firmly to the shell. (Cast iron and malleable iron shells are not tinned). Standard anchor holes should be generous in number and should be located near the ends and at the edges of lubricating holes of all bearings in order to hold the babbitt firmly at the edges.

VII. Sizes of Mandrel:

1. Mandrels for solid bearings.

Mandrels for all solid bearings, both tinned and untinned, should be made with an allowance of .004 inches to .010 inches for broaching to size. The longer the bearing the greater the allowance.

2. Mandrels for split bearings (Iron Shells).

Mandrels for iron shell split bearings up to 6 inches diameter should be made with an allowance of .06 inches for boring to size. When mandrel is over 6 inches diameter it should be made with an allowance of .06 inches to .12 inches. The longer the bearing the greater the allowance.

3. Mandrels for split bearings (Bronze Shells).

Mandrels for tinned bronze shells split bearings up to 7 inches diameter should be made with an allowance of .03 inches to .06 inches for boring to size, when mandrel is over 7 inches diameter they should be made with an allowance of .06 inches to .16 inches. Here also the longer the bearing the greater the allowance.

VIII. Heating of Mandrels:

Mandrels are heated, to prevent the chilling of the babbitt when poured, and are coated with a thin wash of red clay mixed in water to prevent the babbitt from sticking to the mandrel and to prevent blow holes in the babbitt lining.

1. Tinned pipe shells and solid bronze shells.

Preheat mandrel to 100 degrees C. to 125 degrees C. and maintain at this temperature, dip into a thin mixture of red clay wash before babbitting each shell.

2. Tinned split bronze shells.

Preheat mandrel to 125 degrees C. to 150 degrees C., and maintain at this temperature, coat with a thin mixture of red clay wash; this can be applied with brush or swab.

3. Split or solid cast iron and malleable iron shells.

Preheat mandrels to approximately 300 degrees C. to 350 degrees C. and coat with a thin mixture of red clay wash; this can be applied with brush or swab.

IX. Heating of Shells:

1. Preheat cast iron and malleable iron shells to a temperature of 200 degrees C. to 250 degrees C. before babbitting so that the babbitt will flow close to the shell and also permit the shell and babbitt to shrink together and avoid loose babbitt.

2. All tinned shells (bronze castings and steel pipe) must be poured immediately after the tinning operation and no additional preheating is necessary.

X. Babbitting:

1. Care of babbitt metal.

The babbitt must not be allowed to become hotter than 490 degrees C. (914 degrees F.) at any time and it must not have any metal or other alloy mixed with it. Use a pyrometer for determining the temperature and wherever possible use a regulator for controlling the temperature of the metal in the babbitting pot. Melt the babbitt in an iron or steel pot, maintain the temperature of the metal when in use between 460 degrees C. (860 degrees F.) and 482 degrees C. (900 degrees F.) and at no time permit the metal to be heated above 490 degrees C. (914 degrees F.) Mix the metal thoroughly from the bottom of the pot as soon as melted, again at frequent intervals when being used, and always just before using after the metal has been standing in molten condition for any length of time.

If the pot is used only occasionally, cover the babbitt with saw dust or charcoal to prevent the formation of dross.

2. Pouring:

Ordinarily, pour all bearings in a vertical position unless the irregular shape of the bearing makes this position inadvisable, in which case incline the bearing at the most convenient angle and pour at the most convenient point.

In pouring a split bearing at an angle, the parting face should be on the under side, resting on the jig.

Pour from a self skimming ladle and pour in a steady stream directly along the mandrel in order to avoid the pocketing of air.

3. Repairing small defects:

Small blow holes, if few in number, should be filled with the babbitt by the use of a hot soldering iron. If blow holes are large in number, or if seams have formed, the lining should be melted out and the bearing rebabbitted.

Remove babbitt from lubricating holes with a hot soldering iron.

XI. Peening or Rolling:

Peen or roll split cast iron and malleable iron bearings above 5 inches diameter, taking care to compress the babbitt equally over the whole surface. Care must be exercised in peening or rolling the metal not to distort it or produce in it any tendency to buckle. Do not peen or roll the tinned babbitted bearing.

XII. Cleaning Solutions:

1. Hydrofluoric acid solution.

Add 11 gallons of 16 degrees B. (Commercial) hydrofluoric acid to 100 gallons of water. Specific gravity of solution 1.015 at 16 degrees C. or 1.005 at 51 degrees C. Maintain at temperature of 40 degrees C. to 60 degrees C. when in use. This solution must be replaced when it takes on a brownish color.

2. Sulphuric acid solution:

Add 10 gallons of 66 degrees B. (Commercial) sulphuric acid to 100 gallons of water. Specific gravity of solution 1.072 at 30 degrees C. and 1.08 at 68 degrees C. Maintain at temperature of 60 degrees C. to 80 degrees C. when in use. This solution should be replaced when it takes on a brownish color.

3. Caustic soda solution:

Add 38 pounds of caustic soda to 100 gallons of water. Maintain at temperature of 80 degrees C. to 100 degrees C. when in use. Keep surface of liquid free from scum and replace when liquid takes on a brownish color.

4. Red clay wash:

A thin mixture of red clay in water. Just enough clay is used to give red color to the mixture. Stir before using. This solution should be replaced when it turns from a milky to a brown color.

XIII. Materials:

1. Shells are made of cast iron, malleable iron, bronze or steel pipe as specified.

2. Babbitt metal.

The babbitt metal for which this process was originally prepared was that known to Westinghouse Electric & Manufacturing Co. as alloy No. 25, with Brinell hardness of not less than 25 and not more than 31, and at the present time it is processing approximately 40 tons of this alloy each month.

3. Alloy No. 19 is a soldier used for tinning the surface of bronze and steel pipe bearing shells (approximately 35 per cent tin, balance lead).

4. The tinning flux used is zinc chloride (a saturated solution of zinc in hydrochloric acid) carried at East Pittsburgh as soldering flux No. 2.

5. Sulphuric acid—commercial grade (66 degrees B.)

6. Hydrofluoric acid—commercial grade (16 degrees B.)

7. Caustic soda—98 per cent caustic soda.

8. Red clay—a clean mud clay.

9. Graphite—commercial grade.

10. Charcoal—commercial grade.

11. Hydrochloric acid—commercial grade.

In concluding these remarks, I wish to emphasize to you gentlemen the importance of the proper making of the babbitt metal.

The composition may be that known to have given good results when properly made and yet give very poor results when improperly made. It requires equipment, skill, supervision and tests to make it right. It requires daily tests from the babbitting pots, when they are in use, to make sure that the metal is kept right.

The bearing once made, however, must be used with judgment if we are to get real commercial results. It must be properly aligned and provided with a flow of oil through it.

Therefore, a babbitt of proper high quality, a bearing of correct design for strength, lubrication and pressure, adequate babbitting facilities, skilled help and correct processes, should produce good results.

If these pages from the book of experience are found helpful to you, I shall feel fully rewarded for this privilege.

FATIGUE PROPERTIES OF ALUMINUM.

In a paper entitled "Fatigue and Impact Fatigue Tests of Aluminum Alloys," read before the American Society for Testing Materials at its twenty-third annual meeting recently held at Ashbury Park, N. J., W. A. Gibson described an investigations to determine the fatigue properties of cast, forged and heat-treated aluminum alloys, and to relate these properties to the corresponding properties of steel alloys used in places where it is thought aluminum might advantageously be used.

Results of a series of tests were given upon two types of cast alloys in fatigue and in impact fatigue. Results of three series of tests in fatigue were also given upon forged duralumin, with and without heat treatment. One series of tests was given upon a heat-treated carbon steel. In impact fatigue, a series of tests were given upon various duralumins and upon a very mild steel, a heat-treated carbon steel such as is commonly used in forgings, and upon a nickel steel.

In comparing the fatigue-resisting properties of forged duralumin with those of the common grades of steel forgings, the conclusion is drawn that for sections of equal size the aluminum alloys are equal to, if not superior to, forged steel.

LARGER SUPPLIES OF MANGANESE.

The scarcity of manganese which seemed to be threatening the United States earlier in the year is not probable now. The output of ferro-manganese has been steadily mounting each month until in June it reached 26.265 tons, according to the blast furnace reports of "The Iron Age," which include an estimate of the electric furnace output. The average for the second quarter is 5,300 tons per month larger than that for the first quarter, or 23,318 tons against 18,049 tons per month. At the present rate of 20.684 tons per month for the first half, the year's output will exceed 248,000 tons. The imports are also growing, those for May having been nearly 4,000 tons, the heaviest in the last seven months and exceeded only three times in 1919. Ore imports are also increasing, having been twice as large in April and May as in the first quarter, or 91,674 tons for the two months, against 44,539 tons for the three. Thus the rate to June has been over 27,000 tons per month or very nearly equal to the 1919 movement.

If the domestic production of ferro-manganese continues at the present rate and the imports equal the average thus far maintained, the steel industry's needs for 1920, assuming a production of 44,000,000 tons of ingots and castings for the year, will easily be met.

Manufacture of Broad Flanged Beams with Perfectly Uniform Flanges

Showing the Different Methods of Production on Sack Universal Mill and the Working Process and Construction of Cogging and Finishing Mills.

By A. SCHRIEVER.

SINCE the introduction of the so-called B-Sections by Differdinge the demand for broad-flanged beams has steadily increased. It would even have been heavier, had the section attained the maximum moment of resistance possible for a given height, and also if the price had not been materially higher than for the equivalent German standard section. The cause of the high price of this new section was, that the existing two or three-high mills did not come up to the requirements for technical reasons. It was necessary, therefore, to roll such a section in a so-called universal mill, which might have been accomplished either by the installation of a special rolling mill, or else, by the remodeling of existing installations.

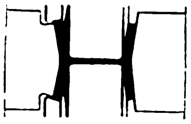
Fig. 1—Universal roughing pass.

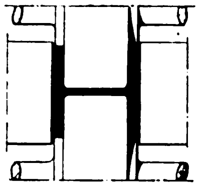
Fig. 2—Finishing pass in the universal mill.

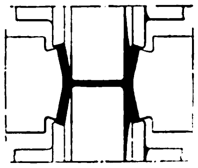
Fig. 3—Pass of the universal mill. Two housings arranged side-by-side or behind one another for turn-over arrangement.

Under the former heading three processes have been introduced in Germany so far, namely:

1. The process by Grey (Differdinge method).
2. The process by Puppe (Peine method).
3. The process by Vassen-Goebel (not yet in practical use).

These rolling mill installations require a very considerable outlay of capital, and as they are only suitable for the manufacture of I-Sections, the redemption of the capital is a difficult matter and necessitates a higher price than that of the German standard sections. The adoption of existing plants to the manufacture of this special section has only been attempted by one German firm, namely, Messrs. Sack. The development of the process used by this firm will be described below.

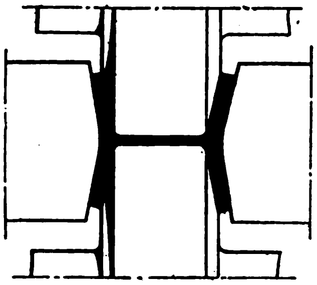
Fig. 4—Pass of the universal mill. Two housings being arranged side-by-side or behind one another for avoiding turn-over arrangement.

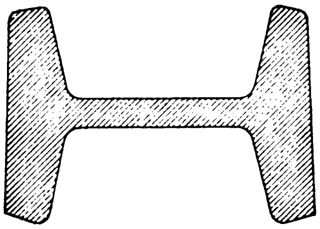
Fig. 5—First shape for the universal mill.

The process is distinguished from those classed under 1 to 3 by rolling all sides of the web, flanges and edges simultaneously in the same pass, thereby obtaining the most favorable working process for the material. The method used is as follows: A rough I-Section, produced by a standard two or three-high mill, is rolled, in a so-called universal mill, to a double Y-Section which corresponds approximately to the finished dimensions of the desired I-Section. This is done by a great number of passes, the horizontal and vertical rolls being adjusted continually. The flanges of this double Y-Section are merely flattened out afterwards. The pass of the rolls is shown in Fig. 1. While the flange material is merely flattened, shaped and jumped on the other side, this jumping being necessary for the finishing of the edge. As the beam is turned over 180 degrees after each pass the finishing the edges during the course of this process is quite sufficient. In order, however, to finish the edges

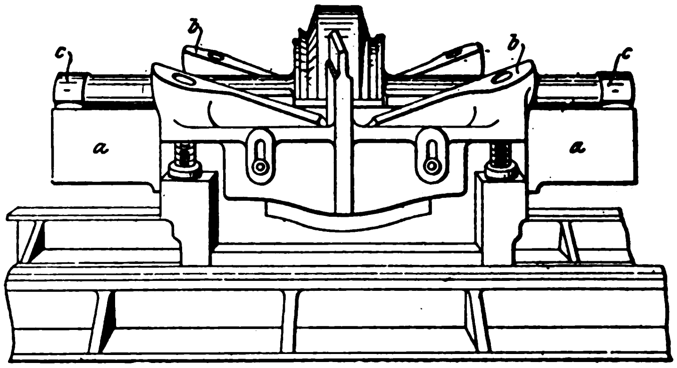

Fig. 6—Bottom roll with carrier plate (first stage of construction) (a) carrier plate; (b) guides; (e) bottom roll.

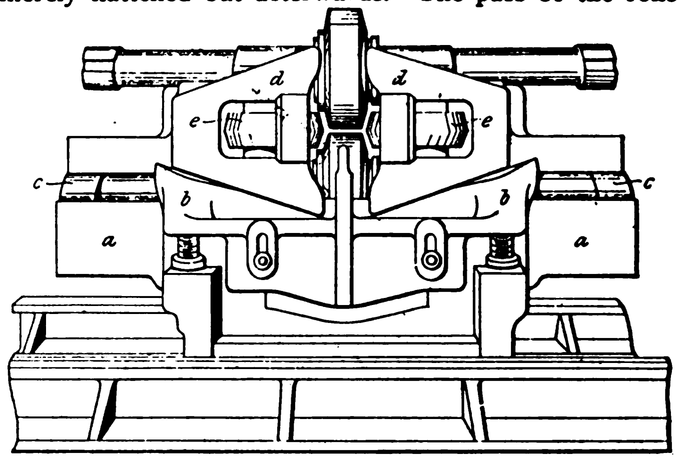

Fig 7—Bottom carrier plate with inserts for vertical rolls and upper universal roughing mill (second stage of construction). (a) carrier plate; (b) guides; (e) bottom roll; (d) insert for vertical rolls; (e) vertical rolls.

still better the roll housing according to Fig. 1, has been subdivided, into two housings standing one behind the other, or side by side (Figs. 3 and 4) in the housing according to Fig. 3 all four edges of the flanges are jumped up uniformly under a pressure nearly equal to the pressure on the web. The material of the edges, therefore, attains the same strength as the material of the web. In order to avoid the formation of a bur without using an edging apparatus the second roll housing has become necessary. The number of rolls used is thereby doubled which means a considerable capital outlay. The redemption of this large capital is not an easy matter and the prices of the finished beams are naturally high.

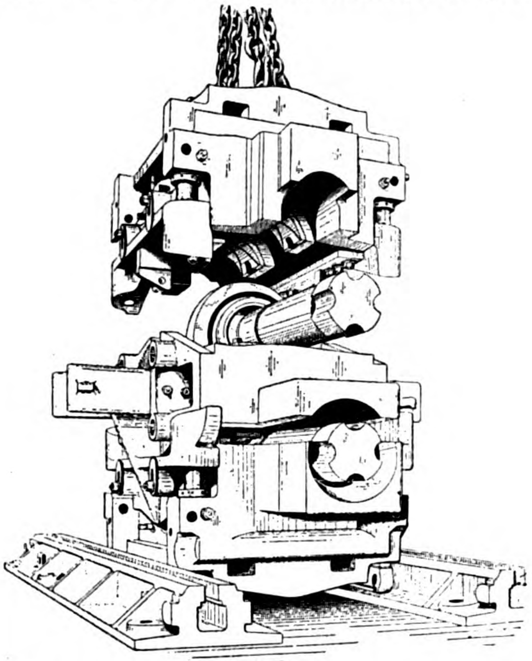

Fig. 8—The upper carrier plate is placed over the horizontal roughing roll (third stage of construction).

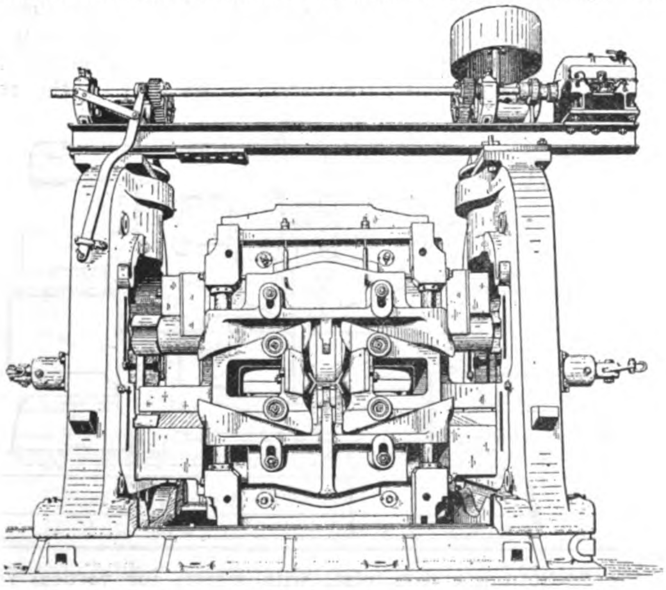

Fig. 9—Front view. The two roll housings are ready for receiving the universal insert (fourth stage of construction).

Exhaustive tests have shown the most favorable inclination of the flanges during the rolling in the universal roughing mill to be 1:5, whereby the material of the edges theoretically receives the same pressure as the material of the webs. The beam finished in a quadruple rolling mill therefore obtains a uniform pressure from all sides so that internal stresses in the beam are entirely eliminated. While the finishing of the flanges and webs according to Figs. 3 and 4 is distributed over two roll housings it may be conveniently done in one housing also, according to Fig. 3, the second housing, or the previously mentioned edging apparatus being only necessary in order to prevent the formation of a bur; this bur, however, is only produced by the so-called roughing passes. The bur consists of excess material pressed out through the joints of the passes. If during rough rolling care be taken to produce a lack of material at the outside edges of the flanges, the formation of bur cannot take place at all.

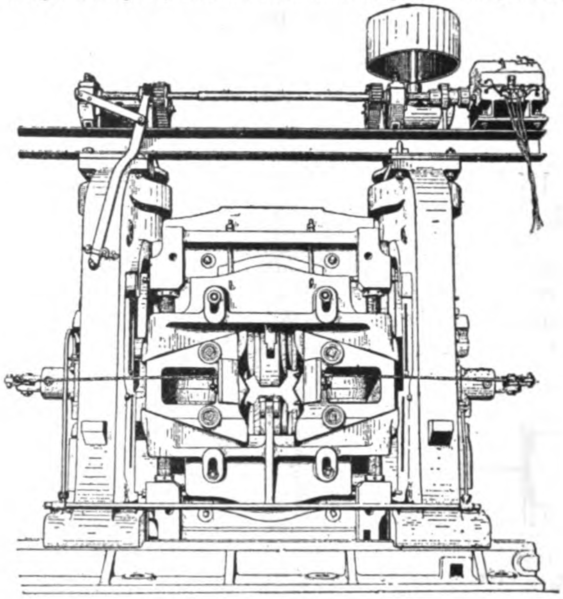

Fig. 10—The universal mill assembled and ready for passing the first shape according to Fig. 5 (fifth stage of construction).

Arrangement of a Rolling Mill for Broad-Flanged Beams.

A Sack-System mill for producing broad flange beams of uniform flange thickness consists of (a) the standard two or three-high mill, (b) the universal roughing mill, (c) the universal finishing mill.

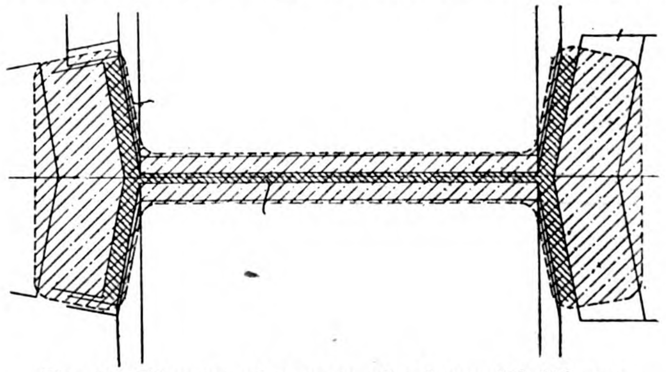

Fig. 11—Diagram of process of a beam 300x300 mm.

The standard two or three-high mill serves for producing the so-called rough section for the universal roughing mill, of a rough I-shape as shown in Fig. 5. It is fitted with rolls of 850-900 mm. diameter, 2,700 to 2,900 mm. length of the usual type existing in many rolling mills. If higher sections than customary at present (550 mm.) are to be produced, and if the mill has no adjustable toproll, two or three of such two or three-

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high mills may be necessary in order to produce the rough section as shown in Fig. 5. Either a billet or an ingot is used as original shape. As this mill does not present any special features the description of the same is unnecessary. The universal roughing mill is a quadruple mill consisting of two driven horizontal rolls and two vertical friction rolls, all of which are arranged in the same plane. In designing this mill the following four cardinal points had to be considered:

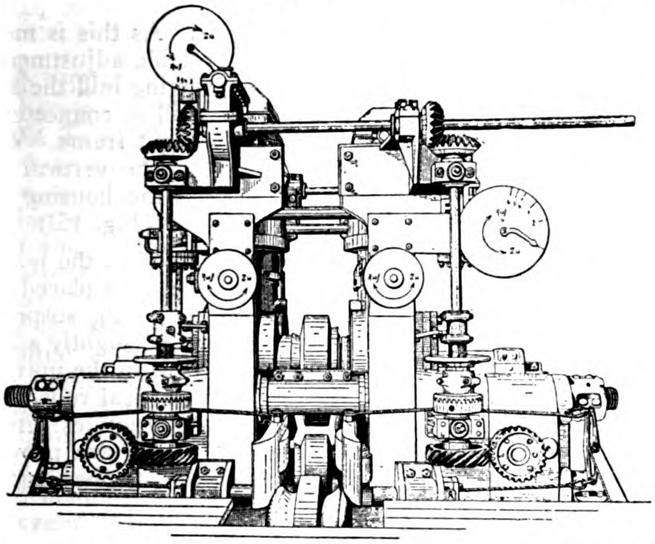

Fig. 12—Universal roughing mill with four adjustable rolls (front view).

1. The rolls used had to be accommodated in the existing housing of the 900 and 950 mm mill, respectively.
2. Any new mill housing, which had to be provided, had to permit of a simple changing-over from the universal set to the normal two-high set.
3. The bottom roll should be fixed, whereas the three others should be adjustable, according to a definite ratio determined by the housing.
4. All four rolls should be adjustable independent, as well as dependent, of each other.

These conditions have been complied with by two different designs, each of which meets the conditions under 1 and 3, or 2 and 4, respectively, namely, (a) by the design of the housing with stationary bottom roll, and (b) by a housing with four separately adjustable rolls.

Housing With Fixed Bottom Roll.

The design of a housing with fixed bottom roll will now be described: Fig. 6 shows the bedplate (a) with the parallel rails (b) and the bottom roll (c) fitted into place. The parallel rails (b) are designed with broad surfaces and serve for supporting and guiding the containers (d) of the vertical rolls which are provided with corresponding surfaces, inclined in opposite direction. These containers are massive hollow cylinders in which the vertical rolls are supported by means of collar bearings, rigid lateral guides with stripping pieces being bolted to the outside. Fig. 7 shows the insert with containers for the vertical rolls attached. Thereupon the upper horizontal roll (f) is put on, and on top of it is placed the upper carrier plate (g) of the same design as the bottom plate, which also contains the horizontally adjustable bearing of the roll (Fig. 8). Fig. 9 shows the front view of the housing completely assembled, with the exception of the putting together of the roll housings (b) whereby the carrier plates and vertical containers are suitably guided and held in place. The roll-pass shows the final pass, i.e., the finished section, which will only have to be bent straight. Fig. 10 illustrates the front view of the assembled housings with the pass ready for the starting operation.

Working Process.

The working process is as follows: After the rolls have been properly adjusted, the billet is passed through, thereby changing the rough I-shape of Fig. 5 into a double Y-shape. Then the pressure screws are adjusted by means of a 30 hp motor, which overcomes the hydraulic pressure of the balancing and pull-back cylinders of the vertical rolls. This causes the upper carrier plate and toproll to move downwards. The oblique surfaces of the upper parallel rails press upon the bearing surfaces of the vertical containers of opposite obliquity, causing them to slide downwards upon the lower parallel rails, thereby narrowing the pass also horizontally. The ratio of adjustment is constant, corresponding with the dimensions of the finished beam. In the present case this ratio is 2:3, i.e., with an adjustment of the upper horizontal roll of 2 mm, the vertical rolls are shifted 3 mm in horizontal direction and at the same time lowered by such an amount that their center is exactly in line with the center of the horizontal rolls. The adjustment is repeated in this housing until the finished dimensions of the beam have been obtained. Fig. 11 illustrates the exact position of the rolls when rolling a 30 gauge beam. In order to change the ridge of the bur, it is necessary to turn the beam over 180 degrees after each pass, which is accomplished by a suitable design of turning device, provided in the train rolls fore and aft of the mill. It is not recommended to make the adjustment of the rolls completely interlocking, by the design of the housing. The adjustment should be such that single rolls may be adjusted without affecting the adjustment of the rest. This condition must be complied with in order to guard against the uneven wear of the rolls.

The adjustment must be adaptable to the various temperatures, and the adjusting device must be such that mistakes in the adjustment may be corrected during the process. Moreover the dimensions of the finished beam must be variable within certain limits. After the size of the finished beam has been decided upon, however, it is advisable to work according to a definite adjustment of the passes. Slight variations must, nevertheless, be pos-

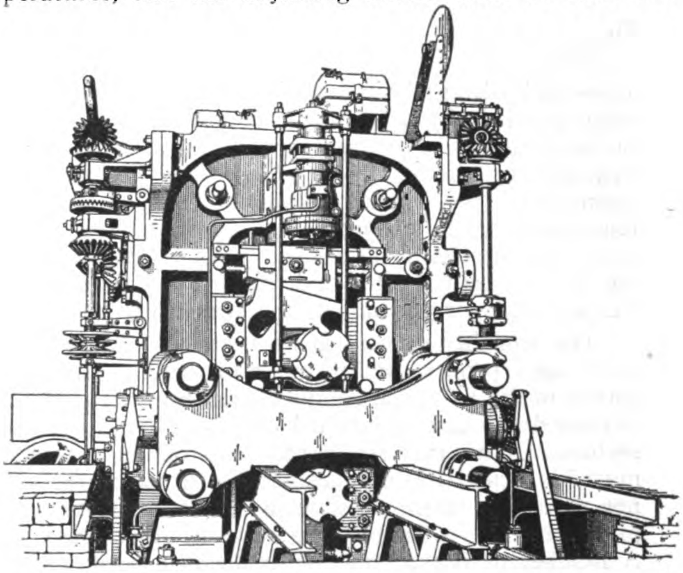

Fig. 13—Universal roughing mill with four adjustable rolls (side view).

sible, as a too rigid adherence to the schedule would lead to inaccuracies.

Changing Standard Two-High Mills Into Universal Mill.

To change a standard two-high mill quickly and without difficult operation, into a universal mill with four adjustable rolls, cannot be done with existing housings of standard design. It will, therefore, be necessary to provide new housings which, except for a few additional brackets, need not present any special features. The sketches Figs. 12 and 13 show a housing of this description. The pressure of the vertical rolls is not transmitted to the housing, but is taken up by the tension in the anchors. If the anchors are properly dimensioned the spring of the rolls at this point is correspondingly small. As the face of the rolls is changed with each section, it is not necessary to alter the housing, but merely to adjust the inserts horizontally. The toproll is pressed tightly against the inserts with uniform pressure by two hydraulic cylinders, whereas the bottom roll merely rests in its bearings with the pressure due to its weight. The adjustment or advance of the rolls is effected by a 36 hp motor working through a gear and spindle transmission upon the wedges. As the vertical rolls must always be accurately in the center of the web, they need only be adjusted horizontally in a straight line. They are shifted simultaneously by a 36 hp motor and held against their thrust bearings with uniform pressure by means of hydraulic cylinders. During the rolling process the adjustment of each pair of rolls is interlocking. It is very important for the proper rolling operation that the vertical friction rolls turn very easily, as otherwise a straining occurs between the material of the web and the flanges, which would impair the strength of the beam.

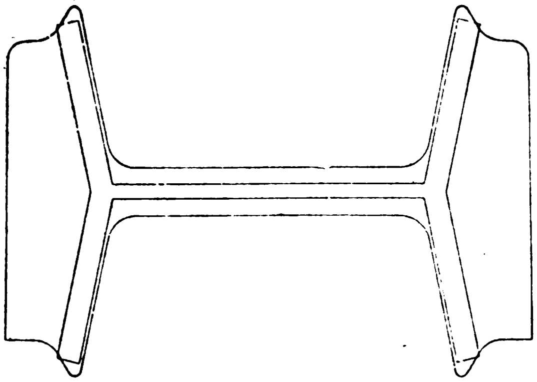

Fig. 14—Shape for the universal roughing mill, avoiding turnover device for auxiliary mill for shaping edges.

The working process is as follows: After all rolls have been properly adjusted, with due regard to the spring in the rolls, the rough section according to Fig. 5 is passed through and rolled out to a rough double Y-section. After this shape has been obtained the beam must be turned 180 degrees after each pass. This does not involve a waste of time, as the turning over takes place while the rolls are being adjusted for the next pass. A number of passes are now made in succession in the same housing until the approximate finished dimensions have been obtained. The beam must now only be passed through the finishing rolls. In order to remove the bur without employing either a second set of rolls or an edging apparatus it will be necessary to use a preliminary pass, as shown in Fig. 14. While the flange thickness remains the same in this case, the edges must be formed differently, that is to say, there must never be any excess material on the outer edges of the flanges during the entire rolling process. This applies also to the passes of the universal cogging mill.

Universal Finishing Mill.

The universal finishing mill is likewise a so-called quadruple mill with two driven horizontal rolls and two vertical friction rolls in the same plane. The pass of these rolls has been shown in Fig. 2. As this is merely a polishing mill it requires no appreciable adjustment of the rolls. Similar to the universal cogging mill the housing of a normal 900 or 950 gauge mill is connected by four strong anchors so as to form a rigid frame. These anchors carry the thrust bearings for the vertical rolls upon overhanging brackets. Between the housing suitable distance pieces have been provided (Fig. 15.)

The two horizontal rolls are contained in the housing in standard bearings. A transverse beam is placed over the two adjusting screws, the top roll being suspended from this beam in such a manner as to be slightly adjustable. The vertical rolls are supported as in the universal cogging mill. The containers of the vertical rolls at the same time are provided with rigid lateral guides between the housing, which on the outgoing side are provided with a device which safely presses the strippers against the rolls, assuring a positive release of the material.

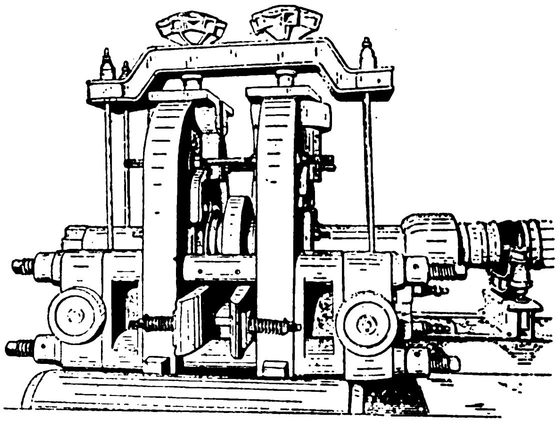

Fig. 15—Universal finishing mill (outlet side).

After the pass has been adjusted correctly the containers of the vertical rolls are connected rigidly with the thrust bearings (traverses). This enables a rigid system of finishing rolls being inserted without difficulty into any existing plant.

Fitting the Broad-Flanged Mill Into an Existing Plant.

After having been prepared the billet is given a rough I-section either in the first set of rolls of the 950 gauge two-high mill solely, or in the first and second set of rolls. Thus the shape shown in Fig. 5 is obtained. In accordance with the prevailing conditions the universal cogging set could only be placed in the fourth position; the billet, therefore, had to be moved from the second to the fourth set of rolls. From the fourth set the beam enters the finishing rolls placed in the third position. This arrangement had to be adopted, because the standard practice on this plant always had been to finish the shape in the third set of rolls. Behind the third set is the discharge table, and connected with it the roll table leading to the hot saws. After the finished beams have been cut to the correct length they are conveyed to a cooling bed where they are allowed to cool. They are then straightened by means of suitable presses.

The Reactions of the Open Hearth Boil

Descriptions of an Open Hearth Boil Showing the Causes for the Same, the Various Reactions as They Take Place and How They Are Visible and the General Result Obtained.

By HENRY D. HIBBARD.

THE BOIL (so-called) of an open hearth steel charge is the chief result of, and quite closely the measure of, the reactions of the bath. It is nearly true to say "no boil, no action," though there may be some going on without boil such as the slow oxidation of silicon in a dead bath containing an excess of that element. This may be the case when a large percentage of pig iron is used in the charge and the charge is quickly melted without ore enough to oxidize the silicon thereof and with a soft flame without undue excess of air in the furnace. The open hearth bath consists of a pool of molten iron containing carbon covered by a layer of molten slag which floats upon it because it is lighter.

The boil is the escape of carbonic oxide (CO) bubbles formed by the union of carbon from the metal and oxygen from the oxide of iron either in the slag or absorbed by the metal from the slag or ore added. That is the way in which excess carbon is taken from the metal to make the content as desired. The iron of the oxide is reduced either to metallic iron or to a lower oxide. In the latter case it may, when at the top surface of the slag, take up fresh oxygen from the air being oxidized to the original oxide and so act as a carrier of oxygen to the metal without being reduced to the metallic form.

Strictly speaking the open hearth charge does not boil but we have no better word to describe the action. Real boiling is the escape of bubbles of a vaporized fluid when heated above its boiling point. To make iron really boil it must be heated above its boiling point 2,450 degrees C., while the open hearth bath is between 1,500 degrees and 1,600 degrees C.

It is beyond the power of language to so describe the open hearth boil that one who had never seen it could tell by the description when looking at it whether or not it was normal or right. Nevertheless, many things may be told about it which the beginner in the shop will find of value and helpful in diagnosing the condition of the bath.

The vigor of the boil may vary in degree from a few small bubbles scattered over the surface, perhaps less than one to each square foot, or even none, to a copiousness which causes the slag to be thrown up in jets all over the bath two feet or more high, or the outrush of gas may even have force enough to blow off a part of the furnace roof. In the latter case, known as the Talbot reaction from it being employed in some moderation in the Talbot process, the escaping masses of gas are large, having perhaps a volume of quarts or even gallons. The jets seem to be the result of the liquid bath rushing in to the evacuated hole from all sides, and, meeting in the middle when the energy of the moving metal and slag is spent in throwing up the jets referred to. In this extreme case the volume of gas liberated is so great that for a minute or so flames 25 feet high play out of the furnace doors, opened for the purpose, and a cataract of slag displaced by the volume of escaping gas bubbles or masses pours out over each door sill.

The vigor of the boil tells how rapidly oxygen is being supplied to the metal and the rate at which the carbon is leaving the metal. To increase the vigor, provided there is more carbon in the metal than is wanted, additional iron ore, preferably in lumps, is added. To decrease the vigor, pig iron, or some manganese alloy is added, or the charge is allowed to boil without ore additions. In the latter case the boil will slacken in intensity because the supply of oxygen available is diminished as the oxide of iron is either reduced or combined with silica when the slag is strongly acid as it is on an acid hearth.

When there is no boil at all, one of these three states exists in the bath:

1. There is no carbon in the metal.
2. There is no oxygen in the metal, or available in the slag.
3. There is an excess of gas solvent such as silicon or aluminum in the metal.

The first two cases rarely occur.

The boil is not only a result of chemical action but promotes further action by stirring the bath and so brings re-acting ingredients into contact so that the reaction may take place. When there is no boil and the bath lies dead because of the excess of silicon present and there is an excess of carbon to be eliminated it can only be made to boil by charging in ore, preferably in good sized lumps up to 100 pounds weight each, which will reach down through the slag into the metal. Then carbon in contact with a lump will be oxidized causing a local boil and some motion of the metal which favors the oxidation of more carbon as well as of the silicon which is the cause of the dead bath. It is a slow operation to make such a bath boil at a proper rate as the silicon over, say .03 per cent must be oxidized and incorporated in the slag.

In a general way acid open hearth steel boils less vigorously than basic with a given carbon content. One reason for this is that the basic slag contains more free oxide of iron which is available for oxidizing the carbon. In the acid slag the oxide of iron is being continually combined with silica from the hearth and thereby incapacitated from oxidizing the carbon so that to keep up the rate of boil fresh oxide (ore) must be thrown in. An acid bath containing considerable carbon, say 0.50 per cent, will therefore, if held molten boil less and less vigorously and in time (a matter of hours) be so dead as to approximate the second case of a dead bath mentioned above.

As an attempt to describe one boil let us take the case of a basic open hearth steel containing 0.50 per cent of carbon, no ore having been added since the carbon was 0.60 per cent say one hour before. The entire surface of the bath is occupied by bursting bubbles of gas varying from 2 inches in diameter down to one-quarter inch in diameter or less. For steel of ordinary quality such may be the boil when the final additions are made or the heat is tapped in case all the additions are made in the ladle. For finer qualities of steel such a boil is too vigorous, as such steel should settle and tend to pipe in the molds and with such a boil an excessive amount of gas solvent would be required which does not conduce to the highest quality. In this case more pig iron or spiegel should be added and time allowed for the carbon to work down again which will lessen the oxide of iron in the slag and metal and so diminish the violence of the boil.

The boil is lessened greatly in vigor by the usual final addition of manganese and much more by additions of silicon, titanium or aluminum when made, all of which have greater calorific power when oxidized than iron. They, therefore, sieze and combine with a part of the oxygen with which the carbon would otherwise have united. Additions of nickel, copper or chromium do not diminish the boil though it would seem that chromium should, to some extent, as its calorific power is given as greater than that of iron, and it should, therefore, have a greater affinity for oxygen.

The points of origin of the bubbles are unknown but it is probable that they begin at all depths in the metal and the lower a bubble begins to form the larger it is when it reaches the surface, as it grows on the way. The smallest bubbles doubtless originate along the contact surface between the metal and slag.

The reaction which causes the boil is endothermic. That is the heat generated by the combustion of a unit of carbon is substantially less than that required to dissociate the quantity of oxide of iron which will yield enough oxygen to oxidize it. Therefore, heat must be supplied by the combustion of fuel to maintain the temperature of the charge as well as to supply the furnace losses from radiation, conduction and convection.

The slag in the wakes of the bursting bubbles give information of the temperature of the metal below. When it is much colder than the surface, as after a large quantity of molten crude iron has been added, the wakes of the bubbles are distinctly darker, that is, colder, than the top surface of the slag around them. As the heat approaches the end the difference in temperature of the metal and slag becomes less and the slag in the wakes of the bubbles is seen to be nearly as hot as the top of the slag. The sound of each boil is also characteristic, though perhaps not describable. When an acid charge is held as above described the slag becomes more and more silicious and glassy and the bubbles break with a sharper, snappier sound.

As stated the boil renders an indispensible service in stirring the charge which forwards the reactions by bringing the carbon and oxide of iron into contact and also helps to clean the metal of the non-metallic impurities which are being more or less continuously formed.

The carbonic oxide escaping probably carries off from the metal some hydrogen and possibly some nitrogen and ammonia. For soft steels made to effervesce freely in the molds an active boil in the furnace is essential but the reason why is not definitely known, though one part seems to be that good effervescing steel is thought to have low hydrogen and nitrogen contents which an active boil may bring about by the above mentioned action.

Reclaiming Iron from Non-Ferrous Material

Description of the Method of Reclaiming Iron from Non-Ferrous Materials for Remelting and to Prevent Damage to Machines from Pieces of Iron—Makes Better Material for Working.

By **HUBERT HERMANNS.**

THE separation of iron from non-ferrous materials may be done for the following purposes.

1. To make the material better suitable for working.
2. To prevent damage to the machines from pieces of iron.
3. To reclaim the iron for remelting.

This separation is now almost universally done by means of electro-magnetic separators, which are provided either with stationary magnets or with adjustable magnets, located inside a drum, which revolves around the magnet. The latter type of apparatus, on account of its continuous operation, is highly efficient, and it is, therefore, exclusively used where quantities of material have to be hauled.

In iron foundries, for instance, electro-magnetic separators are used for freeing the form sand from pieces of iron, thus making the sand better suitable for re-use. In this case, it is not so much the reclaiming of the iron, but the cleaning of the sand which is wanted.

Crushers for rocks, coal, or other materials, which are liable to be damaged by pieces of iron, falling between the jaws, may be supplied with stationary magnets. Fig. 1 shows an arrangement of this type. The magnet is built in a stationary chute in such a way that the down-coming material is freed of its iron, when passing over the magnet. In certain intervals the current is shut off, the magnet removed and the adherent iron scraped off. For continuous operation it is better to have an arrangement, where the magnet is independent from the crusher. The raw material is separated into iron and iron free material, and the latter is then fed continuously into the crusher.

An apparatus for the separation of small iron particles from liquids is shown in Fig. 2. The winding is contanied in a cast iron box, C, to which is attached the magnet, M, and the neck, N. To the latter is attached, on the one end, the handle, H, outside of the bearings, B. By means of this handle, the apparatus can be turned 90 degrees to allow the removal of the iron from the magnet. The winding is built in watertight while the connection to the live wire is made through a hole in the neck opposite the handle, H. The efficiency of the apparatus can be increased by making that part of the bottom of the trough, T, which is under the magnet, of sheet iron or by laying an iron plate, P, into the trough, which will then form a secondary magnet due to the induction from the primary magnet, M.

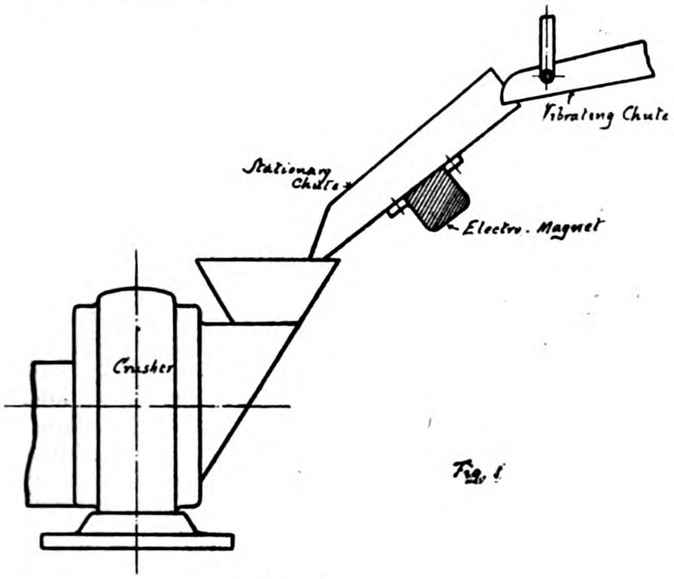

Fig. 1.

The reclaiming of iron for remelting is the most important application of the process today. In foundries and steel mills large quantities of iron and steel have formerly been wasted, but the war has changed conditions and the high prices for pig iron on the international markets as well as the difficulty of obtaining the required quantities of pig iron have changed the economical objects of reclamation completely. It is true, many foundries have used reclaimed iron before the war, but, at that time there was no urgent necessity to do so from an economical standpoint.

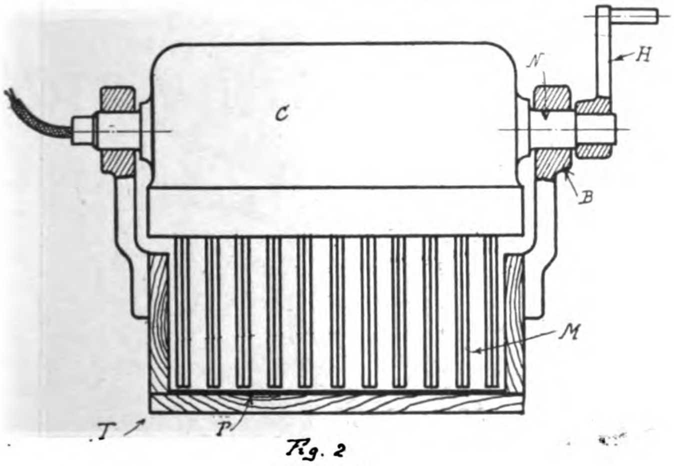

Fig. 2.

Practical experience has shown that the loss of iron in slag and refuse amounts to from one to three per cent of the finished castings. To this amount must be added about two per cent losses in the moulds, and one to 1½ per cent losses, due to chemical reaction in the cupola or furnace. The figures are, of course, different for different foundries. They are smaller in well managed foundries, higher in others. Under ordinary conditions, the iron losses in iron and steel foundries, aside from those due to chemical reaction in the furnace, amount to from 4 to 10 per cent of the finished cast product.

It is a well known fact, that the electro-magnetic separation of iron from slag and refuse is based on the principle that a magnet attracts the iron, which is, with the refuse, brought near to it. Thus the iron is separated from the slag and refuse, as the latter, arrangement is shown in Fig. 3. The material to be, being non-magnetic, is not attracted by the magnetic force lines. The apparatus used for this kind of separation consists of a fixed magnet and a drum revolving around it. The magnets are arranged in such a way, that the magnetic field comprises only a certain part of the surface of the drum. A diagram of this separated is fed from the chute onto the drum and passes over the magnet. The non-magnetic material falls by gravity from the brow of the drum into a suitable receptacle or conveyor leading to final delivery, while the iron is attracted to and held firmly against the drum, until the latter passes outside the magnetic field on the under side, where the iron is discharged.

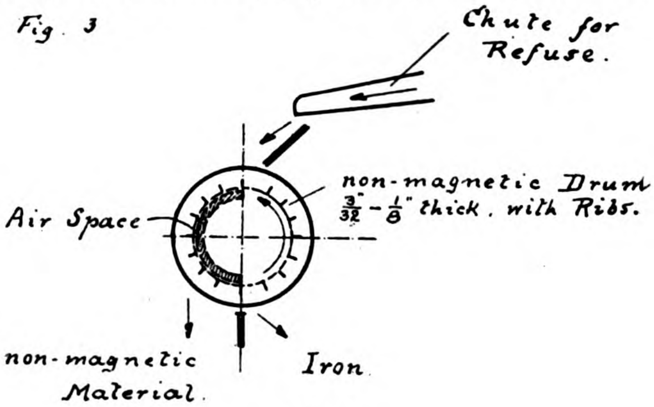

Fig. 3.

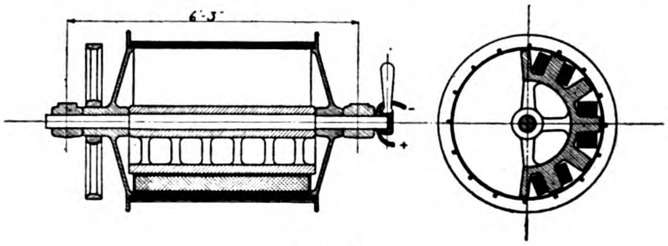

Fig. 4.

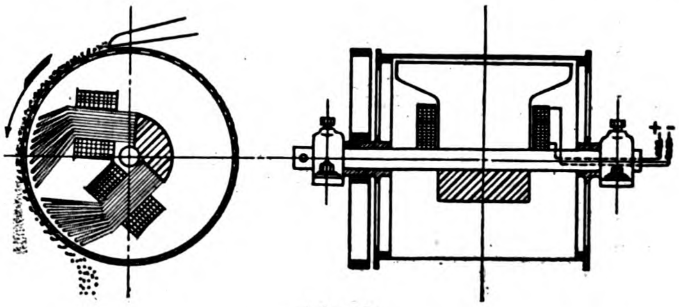

Fig. 5.

In order to obtain the highest efficiency, the form of the magnet is designed in different ways as shown in Figs. 4 and 5, which are self explanatory. Somewhat different from these designs is the one shown in Fig. 6. Here drum and magnets are rigidly connected and revolve around two stationary segments. which are separately connected to the line. The cur-

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rent is conveyed around the magnets by means of slip-contracts, sliding on the magnets. The magnetic material, attracted by the magnets, is discharged at the end of the one segment.

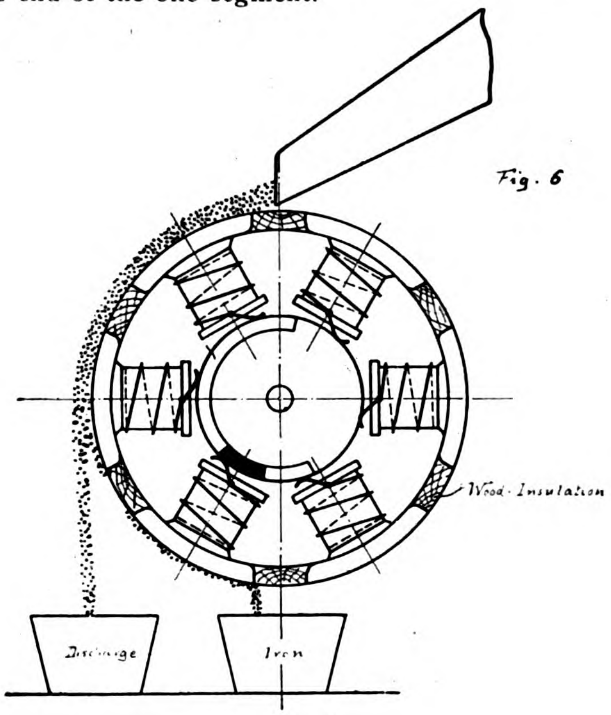


Fig. 6.

For practical operation, it is, of course, necessary to reduce the cost of operation by reducing manual labor as much as possible. The main object in view is the automatic feeding of the drum and the discharge of the final products, separated into metallic iron and refuse, with the least cost.

For small plants, this can be done by means of conveyor belts, feeding the material onto the drum, located above the magnet drum, from where it is brought to the latter by means of a chute. Iron and non-magnetic material are then discharged into separate receptacles, which are carted away when filled.

For large plants it is generally better to provide for transportation facilities, which have to bring the new material to the plant where it is discharged on the drum, after being conveyed there by a bucket elevator. In some cases, it may be necessary to crush the material before it enters the separator, as has to be done, for instance, with slag from cupolas. The crusher, in such a case, will be located between elevator and magnet-drum, and is fed from the elevator. Or, the slag may be crushed first and then lifted by the elevator and fed directly onto the magnetic drum.

When large quantities are to be reclaimed, it cannot be prevented, that, on the one hand some impurities get into the iron, or that, on the other hand, the discharge contains some iron. In such cases if it is required to obtain an iron of high purity or a nonmetallic material without any iron, the refuse must be treated twice. This can either be done by feeding the same material twice into the same separator or by locating two sets of drums on the same level and connect them by a belt conveyor. The best arrangement, however, is to have the two drums vertically above one another in the same housing.

Where the purity of the final product is only of secondary influence, a single separation may suffice, the final product being freed of the impurities by means of a shaking sieve.

The best condition for an efficient working of electro-magnetic separation are to be found in places where direct current with a low voltage is at hand, because the magnets can only be worked with direct current; if only alternating current is available, it must be transformed into direct current.

The size of the electro-magnetic separator depends upon the quantity of material to be handled. Small factories or foundries require a small separator of simple construction, which may be moved from place to place, possibly by means of a traveling crane. The whole machinery can be made self-contained, and may be supplied with rollers to facilitate moving.

Traveling separators are of advantage for foundries of medium size. If tracks are at hand, the separator can be arranged to use these tracks. An apparatus of this kind is shown in Fig. 7. This machine can handle about 150 cubic feet of refuse per hour and consists of a dc motor, a bucket elevator for lifting the raw material to a vibrating screen, two drums with a chute between them, the second drum containing the magnet, and a second bucket elevator which serves for charging the valueless refuse in cars. The passage of the raw material through the separator is in a direction vertical to the direction of traveling. The best and most efficient way of operating this type of a machine would be to work out a plan, according to which the separator would, at a certain day, be brought to a certain place in the foundry to work up the material, which was gathered around the place in question.

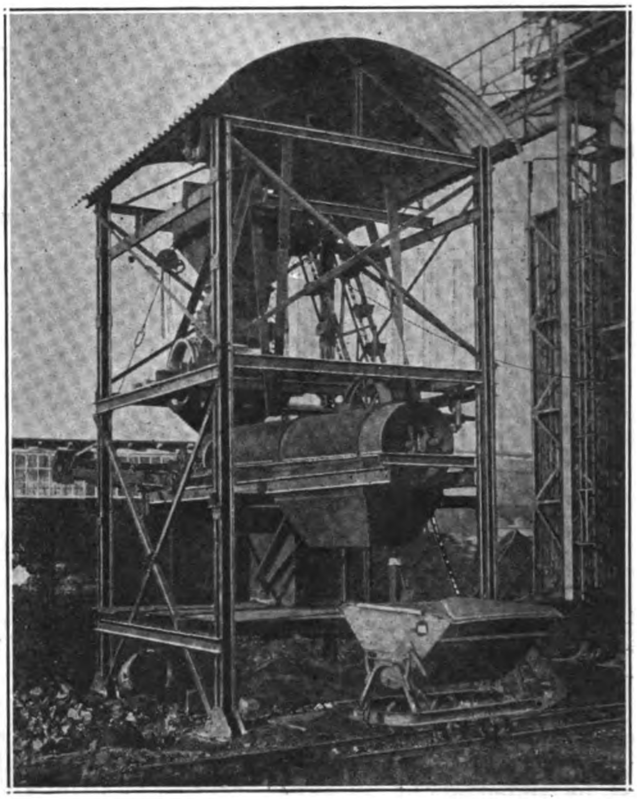


Fig. 8.

The second elevator can be disposed of if it is possible to locate the drums high enough to allow for the discharging of the final refuse directly from the drum into the cars.

The moving of traveling separators is somewhat difficult when they are supplied with crushers, naturally, then, they become so heavy, that they must be moved either by a shifting engine or by means of their own motive power, supplied by a motor. This, however, not only means an increase in the first cost, but also an increase in the operating and maintenance cost.

The crusher not only makes the separator heavier on account of its own weight; the traveling machine which is supposed to have such a crusher as an integral part of the whole machinery, must itself be built heavy enough to be able to withstand the shocks and strains due to the operation of the crusher.

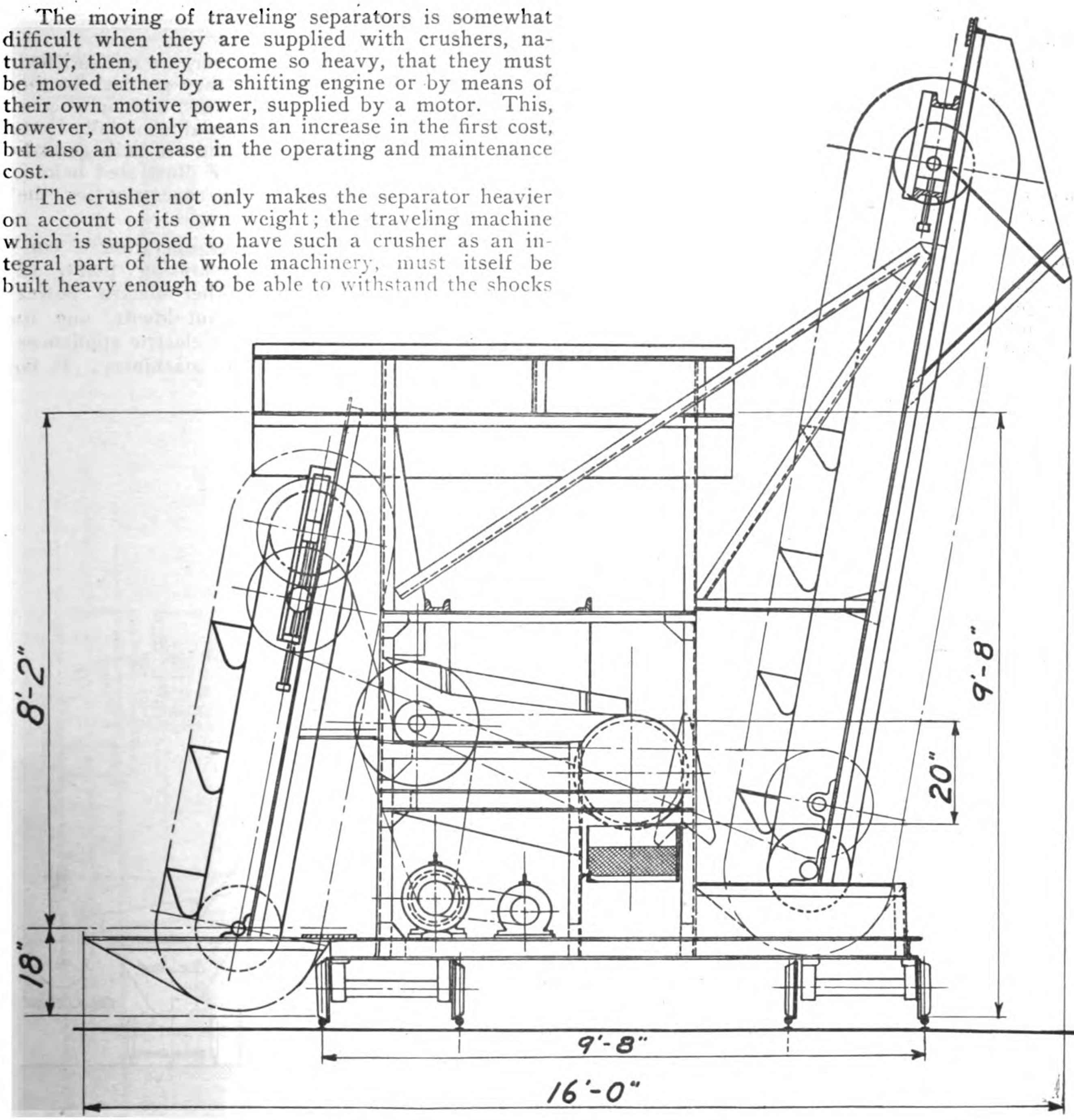


Fig. 7.

It is, therefore, of the utmost importance, when contemplating the erection of a large size separator, to weigh all conditions against each other and select the type best suited for the requirements in question. It will then be seen that, in most cases, a stationary separator is the one best adapted to the prevailing needs, economically as well as technically.

A stationary separator with a crusher is illustrated in Fig. 8. The crusher is located above the magnetic drum. The slag is broken up by hand and then fed into the elevator box together with the other refuse of the foundry. From the top of the elevator the material falls through a funnel shaped box into the crusher and from there on the magnetic drum. The valueless, non-magnetic refuse falls by gravity over the drum and is discharged through a belt conveyed into a receptacle, while the reclaimed iron is freed by a shaking screen from the adherent impurities and is discharged to the side.

The machine can be built a little different, by allowing the valueless refuse to fall, by means of a chute, into a railroad car, or by separating the iron in different receptacles according to its size.

Reclaiming of the iron from the factory refuse is done in steel works to a much larger extent than in foundries because here it is one of the main factors in the strife for economy. In the last years before the war many steel plants had already begun to install electro-magnetic separators and some of these plants obtained up to 11,000 tons of iron per year. This proves the highly economical value of the process. The required expenses are confined to the labor cost for loading and transporting and to the cost of power.

The installation of a separating plant is not depending on local conditions. Fig. 9 illustrates a layout, in which use was made of a natural terrace in the ground. The tracks for bringing the refuse to the separator are laid on the upper terrace, high enough to allow the material to pass through the separator by gravity. The remaining non-magnetic material is again separated, by a vibrating chute into fine sand, which is used for building purposes and into coarser material; it is loaded into different cars, for which the tracks are laid on the lower terrace. The iron passes through a sieve and is freed from dust and other fine impurities and then discharged to the side. All the moving or revolving parts are driven from a common lineshaft, which, in turn is operated by a belt from the motor, stationed in a dust-proof housing.

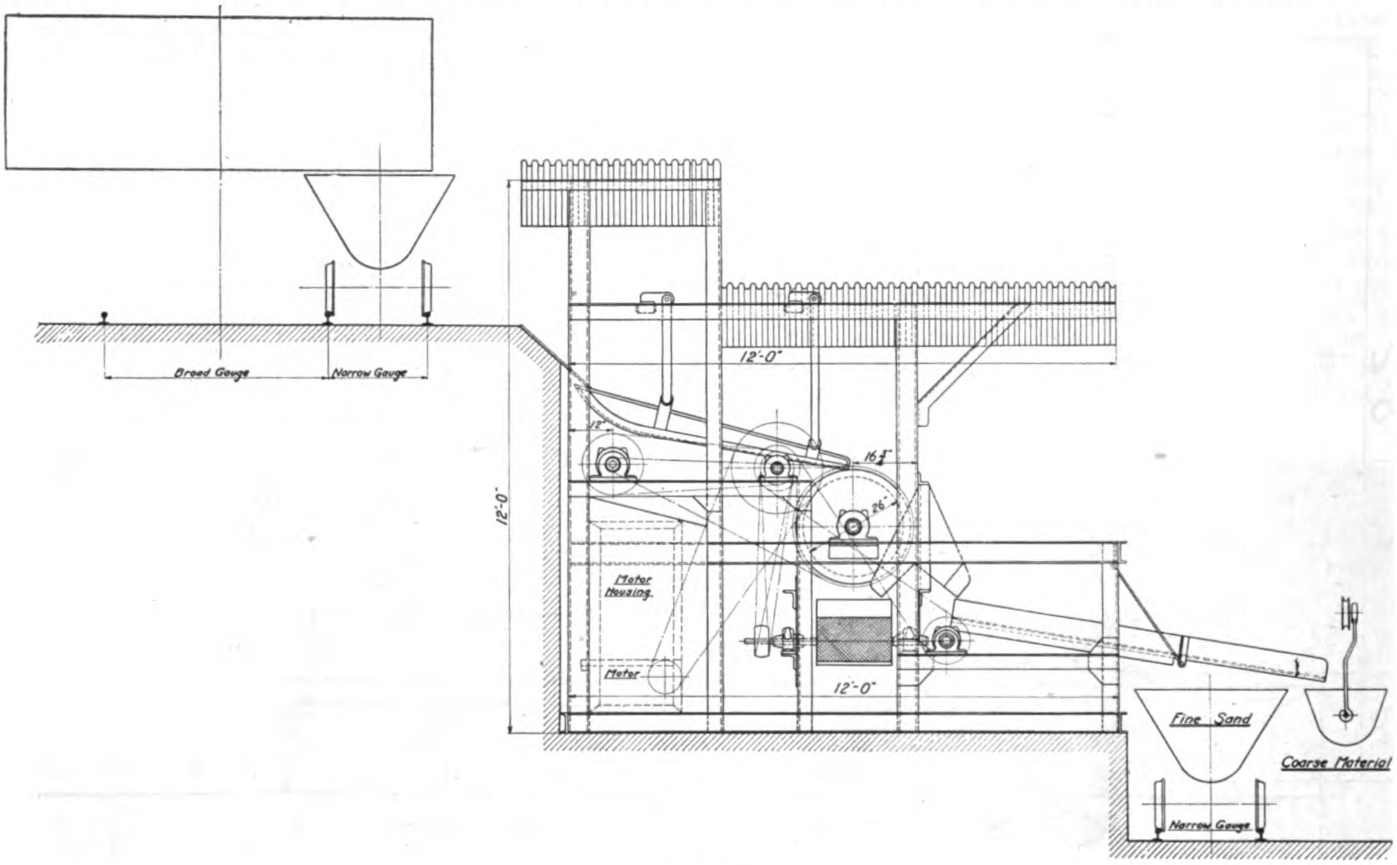


Fig. 9.

If local conditions demand it, the dead material may be discharged by means of a belt conveyor and then loaded into the cars.

Fig. 10 shows the general layout of a reclaiming plant for a basic open hearth steel plant. The material in this case, is to be separated into valueless refuse, slag, lime-ash, coarse iron and fine iron. The reclaimed valueless products are stored separately on an open place, while the valueless refuse is discharged through a chute into the cars.

An installation of this kind shows plainly the high economical value of an electro-magnetic separating plant. Without such an installation, only the coarse iron pieces can be picked out by hand, all the other material has to be taken to the slag pile. Thus, there is not only a loss of iron but also a loss of the lime-ash and the slag from the basic open hearth furnace, both valuable as fertilizers. With the separators all these products can be reclaimed and can be sold in the interest of the steel plant.

Some of the steel plants, however, are not satisfied to only use up the daily refuse; they go back to the old slag piles, which, in many cases, contain a considerable amount of valuable material, especially iron. In general, installations of this kind are built according to the same principle as those illustrated before, varying only in parts, which are necessary for the work the plant is supposed to do.

As far as safe and continuous operation is concerned, an electro-magnetic separating plant, of course, is subjected, like any other electric power plant, to certain unavoidable shut-downs, due to shutting off current, disturbance in electric appliances or wear and tear of parts of the machinery. It is, therefore, important to design the plant heavy and rugged to enable it to withstand rough handling successfully, so as to decrease shut-downs as much as possible. Fine and delicate parts should be avoided entirely.

In general, shut-downs of the separators are due to inattention and carelessness on the part of the operators and can be diminished or entirely avoided by educating and carefully supervising the operating force. Needless to say, that all of the electric contrivances must be protected from the detrimental action of dust and dirt by carefully designed housing. Where these points are followed and when instructions are carried out intelligently, there is no more possibility for any large number of shut-downs of an electro-magnetic separator plant than there is for any other piece of machinery in a foundry or a steel plant.

The operation of a reclaiming plant is very simple,

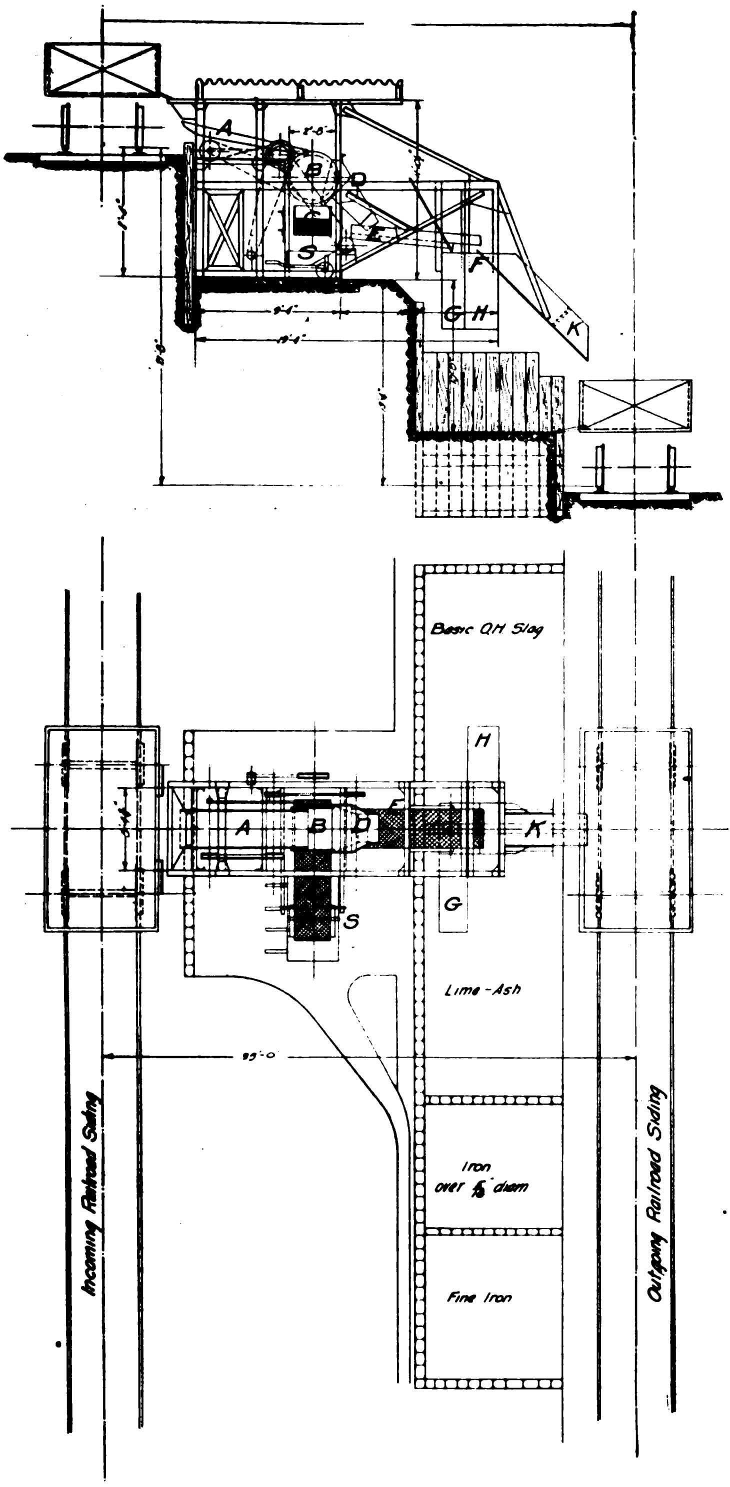
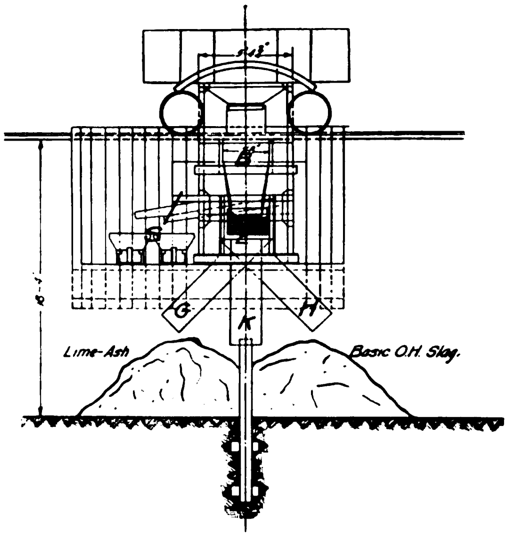


Fig. 10.

All that is required to do after the motor is thrown in, is to charge the refuse into the chute, leading to the drum. In some cases it may be possible to use for this purpose conveying facilities on hand. In large installations separate elevators must be built, unless the shape of the ground allows simpler arrangements. The same holds good for the discharge of the resulting valuable or valueless material. The whole installation must, in every case, be designed and built with a view of as satisfactory and efficient an operation as conditions may warrant.

Necessary repairs can be made by men employed



in the works, as even the smallest plant of the type under consideration has an electrician and machinist on its payroll. The best safeguard against unnecessary shut-down is, however, as was stated before, careful supervision and attendance.

The operating cost is composed of the required percentage for interest on the capital, maintenance and depreciation, salaries and wages, power cost, repairs and the small amounts for oil, waste, etc. For a large plant two men are required for loading the elevator. Charges for transportation do not need to be considered, as the refuse has to be transported anyhow, no matter if it is separated or not. One of the men required for loading the elevators may be used for loading the reclaimed iron.

A calculation into the efficiency of an electromagnetic separating plant, can, of course, only be made for every special installation under consideration of all prevailing conditions. A calculation of this kind will show, that in most cases, and even in small foundries where a favorable result was not expected, the separation of the refuse will prove satisfactory from a financial standpoint. But even if no pecuniary advantages can be calculated, if only the operating costs can be recovered, the interest taken by manufacturers in the economic welfare of a country demands the prevention of the loss of the iron contained in slag and refuse.

Editor's Note—This is the first of a series of interesting articles which are to be furnished exclusive to The Blast Furnace and Steel Plant by Hubert Hermanns, one of the foremost steel mill writers of Germany. Mr. Hermanns will treat of new processes that have been installed recently in European steel plants, both from a theoretical and practical standpoint. He will also furnish data pertaining to the operation of these plants after they have been installed. Because of the rapid development of the steel plants of Europe during the past years, and their eagerness to install the most modern of machinery, these articles will be exceptionally interesting.

Heating Furnaces and Annealing Furnaces

Study of Strength of Tie Rods and Buckstays for Furnaces With Arched Roofs—Strength of Hearths and Foundations and a General Description of Their Construction.

By **W. TRINKS.**

PART XX.

IN A STUDY of the strength of tierods and buckstays for furnaces with arched roofs, it is soon realized that there is a considerable difference between longitudinal tying and transverse tying. In part XIX it was pointed out that tierods and buckstays which are stretched or forced apart by an arch, while the latter is being heated, result in the speedy collapsing of that arch. Conditions are quite different with the longitudinal tierods, Fig. 138. They must yield when the roof expands, because a straight roof cannot rise or buckle. But no harm is done thereby, except that, upon cooling, the brick is not held together, because the tierod, which has been stretched beyond its elastic limit, does not regain its original dimensions. At the next heating, the furnace again bears tight against the buckstays. It is impossible to so place the tierods that their heat expansion equals that of the firebrick, because the coefficients of heat expansion for steel and for firebrick have very nearly the same value. In consequence, the tierod could be made to expand as much as the brick only by being heated to almost the same temperature, in which case it would have insufficient strength. In order to prevent the loosening up of the furnace at each cooling, some designers put helical springs at the ends of the longitudinal rods. They should yield before the tierod reaches its elastic limit.

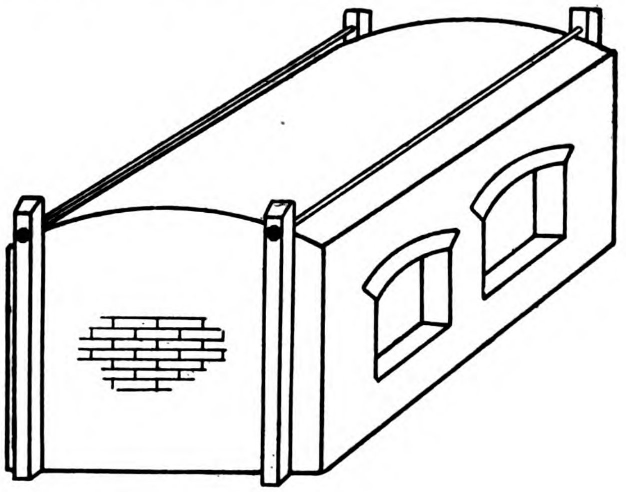


Fig. 138.

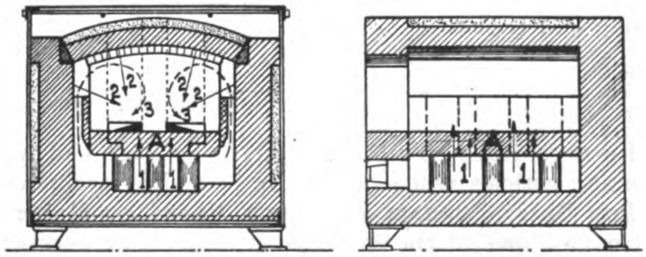


Fig. 139.

It is evident that we cannot make longitudinal tierods strong enough to withstand the expansive force of the brick, and that the tierods are given clearance with a cold furnace. That being the case, how strong should the tierods be made? We might argue, that due to heat expansion, the furnace walls might lean outwardly, and that the tierods should support the horizontal component, say 10 per cent of the weight of the end walls, but this figure results in tierods

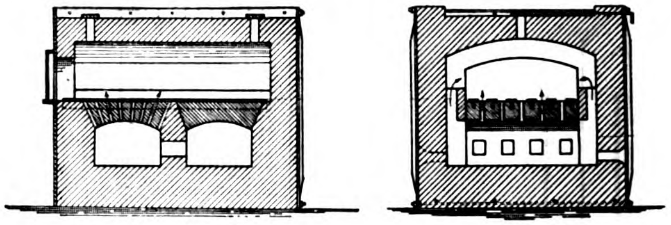


Fig. 140.

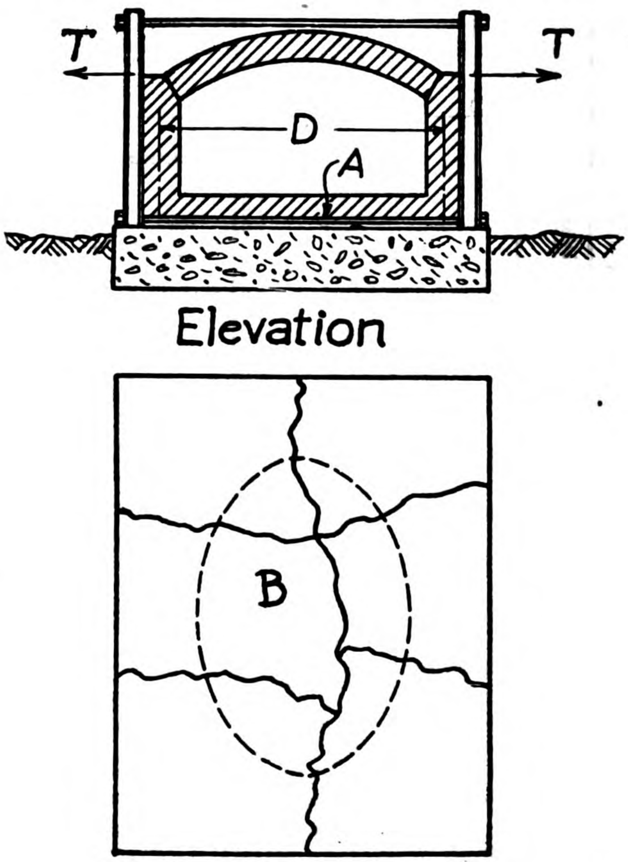


Fig. 141.

which are much smaller than those used in practice. It appears that longitudinal tierods are made about the same size as the cross tierods. They should always be placed high enough to allow rising of the arch. In long furnaces they are preferably laid on top of the cross tierods, to prevent sagging.

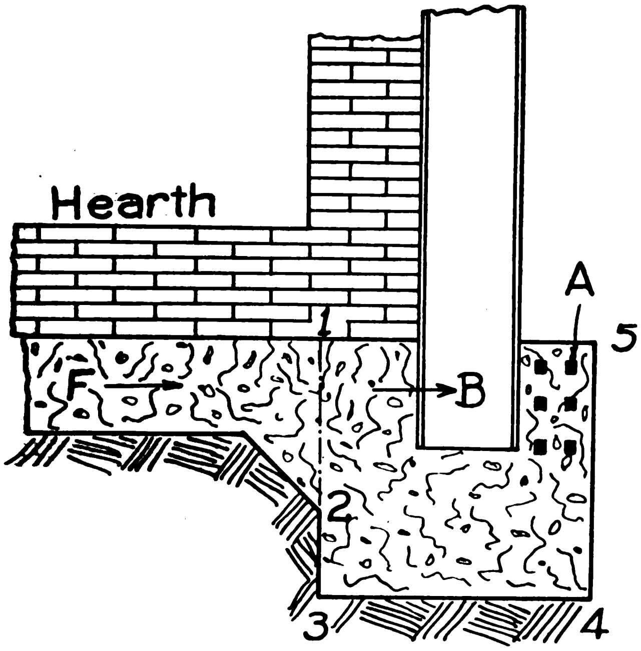


Fig. 142.

The strength of hearths and of foundations is of considerable interest to furnace users. A prolific trouble maker is the hearth of the underfired furnace. This latter type of furnace, see Fig. 139, is intended to heat material on the hearth, A, very uniformly by transmitting heat through the hearth in the direction of the arrows (1) in addition to imparting heat to the material on the hearth by the radiation as indicated by arrows (2). Occasionally, additional heat is transmitted by convection, as indicated by the dotted lines (3). The hearth then has to perform two functions. One of them is to transmit heat and the other one is to carry the load. The two conflict, because the hearth must be thin for heat transmission and thick for load carrying. A few numerical calculations will assist in grasping these facts. Average furnace practice consists in heating from 50 to 60 pounds per square foot of hearth per hour. If one-half of that heat is to be transmitted through the hearth, the valve equals 30 times the heat per pound of steel (assuming that steel is the material to be heated). Let it be further assumed that the steel is to be heated to a temperature of 1,400 degrees F., then the heat that must be transmitted through the hearth will equal 30x230 Btu. per hour (see Part I).

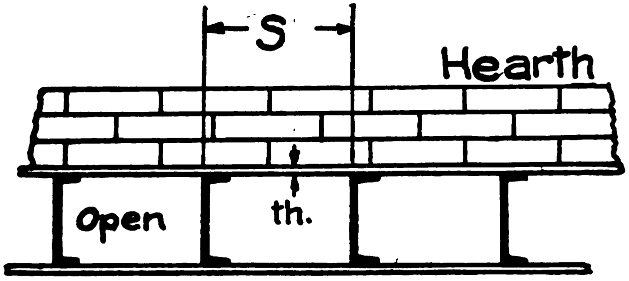


Fig. 143.

An average value of the thermal conductivity of firebrick is 10 Btu. per square foot of area, 1 inch thickness, one hour and one degree F. temperature difference. To transmit 30x230 = 6,900 Btu. per square foot and per hour, we must have the following temperature difference:

Thickness of hearth, 1 inch, 2½ inch, 4½ inch, 9 inch.
Temperature difference, 690 degrees F., 1,720 degrees F., 3,100 degrees F., 6,200 degrees F.

A steel temperature of 1,400 degrees F., plus a temperature difference of 690 degrees F., equals approximately a temperature of 2,100 degrees F. for the combustion chamber, which is quite desirable but a 1 inch slab of firebrick is much too thin to carry any load. Even a 2½ inch slab is too thin, and yet it would result in a temperature of 1,400, 1,720 or 3,100 degrees F. in the combustion chamber. But that temperature is too high for firebrick, see Part XIX, and the only possible conclusion is that underfired furnaces, as ordinarily constructed, that is to say of solid 6 inch slabs or with 9 inch arches can safely transmit through the hearth, only a very small fraction of the total heat generated in the furnaces. For that reason it is advisable to either limit the capacity of underfired furnaces to the value of 30 pounds per square foot and hour, or else to go to special designs or materials.

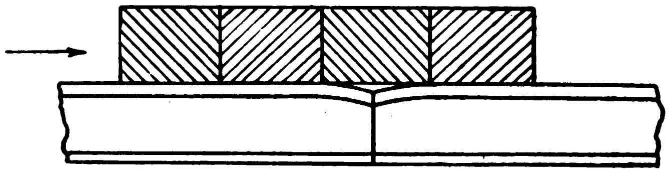


Fig. 144.

For a moderate rate of heating, say 30 pounds per square foot and hour, 4½ inch or 6 inch tile laid on closely spaced piers or partition walls, are fairly satisfactory, but they allow only small combustion spaces. When one large combustion space is aimed at, as for instance the so-called "Rockwell" type, see Fig. 140, a heavy brick arch is required and the advantages of the hot hearth are lost altogether, or almost so. These facts were soon found out in practice, and various means have been taken to overcome the drawback. Perforation of the arch as indicated in the left hand half of Fig. 140 helps, because the holes allow part of the radiant heat to pass up from the combustion chamber. They also allow some of the combustion gases to pass up directly into the heating chamber. Both actions are at once beneficial and detrimental; beneficial because they protect the hearth

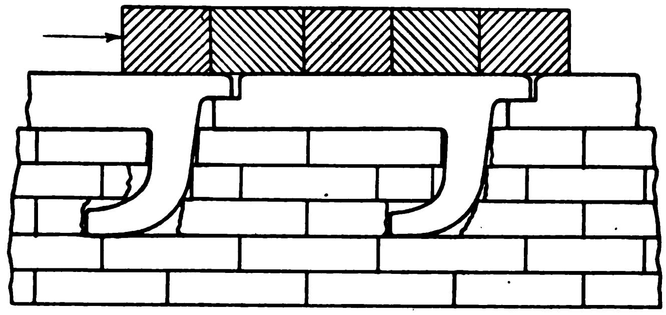


Fig. 145.

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and increase the heating capacity of the furnace; detrimental, because the material is heated in spots by radiation (causing uneven heating) and because the semi-muffle action of the original type of underfired furnace is lost (the products of combustion passing directly between the pieces being heated).

From all viewpoints it appears better to make the hearth solid, but to use a refractory of greater thermal conductivity. Among the various refractories which may be used for this purpose, carborundum stands out pre-eminently. Its thermal conductivity equals seven times that of firebrick and its mechanical strength is about 12 times greater. If, for instance, an arch is laid up of 9 inch carborundum brick, and if a heating rate of 60 pounds of steel per square foot and hour, is desired, the temperature gradiant through the arch will be 890 degrees F. (instead of the 6,200 F. for the firebrick), on the basis of one-half of the heat being transmitted through the hearth. If carborundum slabs of less thickness are used, even more heat can be transmitted through the hearth. The only objection to carborundum at this time is the difficulty of obtaining special shapes and slabs. It is quite a trick to make these shapes right, and it is heart-breaking to wait for shipments if the making of the shapes is entrusted to the Carborundum Company. A good opportunity exists for someone who has learned the knack of making carborundum tile successfully, to go into business and sell them to the various manufacturers of furnaces.

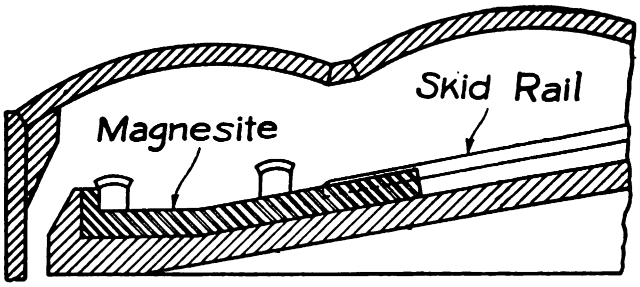

Fig. 146.

Turning now to the hearths of the sidefired or the overfired furnaces, we might, at first thought, expect that they would always be strong enough. Nevertheless, weakness unforseen by the novice occassionally arises, caused almost invariably by the transmission of heat into the foundation. The effects of such heat transfer will now be investigated.

Fig. 141 represents a forge or mill heating furnace (2,200 to 2,300 degrees F.) with a comparatively thin brick hearth resting on a concrete foundation. Two very undesirable results are the outcome of this design. First, the bottom tierods, A, become overheated; they become so soft and weak that the thrust of the arch can stretch them, and the roof collapses as the result of improper hearth design. Second, the center part of the concrete foundation, as indicated by B, within the dotted line of the plan of Fig. 141, becomes quite hot and tends to expand. That tendency is resisted by the outer, cooler edge of the foundation, and no harm results if the brick-hearth is thick enough to protect the center of the foundation from excessive heat; but with a thin hearth, the force of expansion is so great that the tensile strength of the outer edge is overcome, and the foundation cracks into several individual parts or pieces similar to those indicated in the illustration. The position of the cracks naturally varies with accidental locations of flaws and planes of weakness in the concrete. The loads on the different parts of a foundation is never uniform, and purpose of a foundation is to take up that lack of uniformity, causing the load distribution on the subsoil to be practically uniform. As soon as the cracks in the foundation have traveled far enough inward, the different sections settle in different degrees, cracks appear all over the furnace, and collapse is only the matter of a short time.

This melancholy description of the sad results of too thin a hearth naturally brings up the question, how thick a hearth should be, to avoid these troubles. For a hearth of fireclay bricks D/6 is sufficient, if the furnace temperature does not exceed 2,200 degrees F., and D/8 is sufficient, if the furnace temperature does not exceed 1,800 degrees F. (see Fig. 21, Part III), and even with this thickness of hearth it is advisable to add two more features in order to make the design absolutely safe. One of them is to make the concrete foundation thinner in the center of the furnace than around the outside, see Fig. 142. The advantage of this difference in thickness lies in the following: The center becomes hotter than the outside, and tends to expand, as above described. But, if there is a small mass of concrete in the center, and a large mass on the outside, the force which tends to crack the outside layers will be smaller, while the area resisting such tendency will be larger. The second desirable feature is to do away with bottom tierods all together and to bring the bottom end of the buckstays in the foundation. The advantage of this feature is that the bottom tierods cannot become overheated, because there are none.

This latter design is frowned upon by many engineers on the ground that a concrete foundation is not as reliable as a tierod. However, that objection is easily overcome by reinforcing the concrete by rods, see A in Fig. 142. The desirable amount of reinforcing can be judged from the fact that the outer ring of the foundation virtually constitutes a beam of the cross section (1) (2) (3) (4) (5), and is loaded by the buckstay thrust B as well as by the expansion F of the foundation. The shape of the furnace, the thickness of the hearth, the design of the roof, the ratio of the thickness of the center of the foundation to that of the outer ring, all of these factors affect the amount of reinforcing required, but for average conditions the following rough and ready rule gives good results: For every square foot of hearth provide ⅛

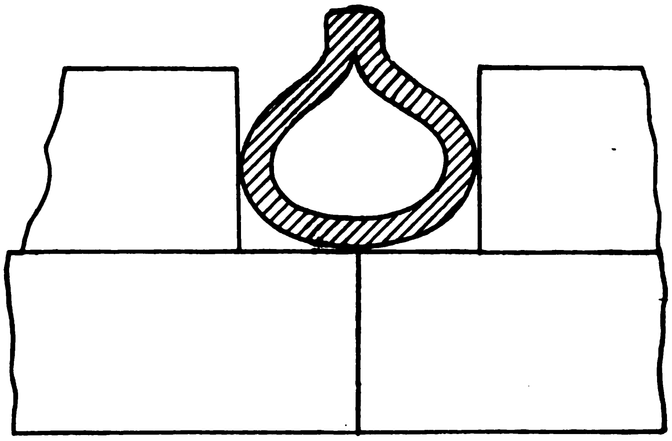

Fig. 147.

square inch of reinforcing rod (in each beam, or on each side of the furnace) for 2,200 degrees F. furnaces and 1/12 square inch for 1,800 degrees F. furnaces.

For large furnaces, say 10x40 feet, or 20x20 feet, this design leads to very thick hearths, and too much reinforcing material in the foundation. For this reason many designers prefer to rest large, high temperature furnaces on open-work structural material, as shown in Fig. 143. Hearths of this type are said to be "ventilated." The thickness of the brickwork is, in this case, determined solely by reasons of keeping the heat losses within reasonable limits. The thickness TH of the supporting plate, the span S of the beams, and the size of the beams, are matters of structural design of the simplest kind and need not be discussed here.

Of great interest is the strength of continuous furnaces through which material is being pushed (continuous billet furnaces). The pushing of material across bricks lying flat is not good, because unequal expansion, or slag working under some of the bricks, will cause sufficient uneveness to make some part of the material catch, which usually tears the hearth to pieces and makes a general mess. For that reason hearth bars or skids of some sort are usually provided. Cast iron is frequently used for temperatures up to 1,600 degrees F., unless furnaces are of the underfired type. Cast iron has the very undesirable property of growing by repeated heating and cooling, and space must be allowed for expansion. Whereever hearth bars are made in sections, it is expedient to round the corners at the joints, see Fig. 144, so that a slight vertical misalignment will not cause any sharp edges to project on which the moving material might catch. Some designers are very careful to prevent rising and buckling of the hearth bars by anchoring each section in the hearth, see Fig. 145. The anchor holds one end of the bar, and a projection of the bar holds the adjacent end of the next bar, allowing sufficient room for expansion.

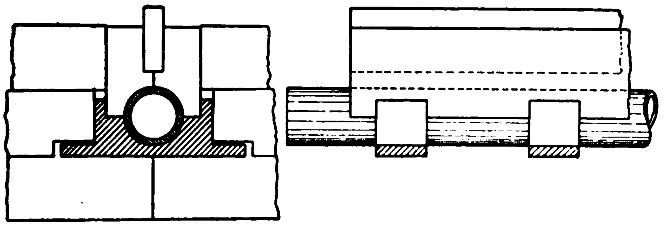

Fig. 148.

Difficulties arise with the hearths of continuous furnaces for high temperatures (2,200 degrees and higher). Hearth bars of cast iron or of ordinary carbon steel cannot be used at the hot end. For small billets the difficulty has been overcome by letting the hearth bar gradually disappear below a hearth of magnesite brick laid on edge, see Fig. 146. The construction is quite satisfactory. Magnesite bricks are preferred to fireclay bricks, because iron oxide does not form a flux as readily with magnesite as it does with fireclay. However, iron oxide has some corroding effect on magnesite, and besides, magnesite bricks do not resist abrasion very well. They wear down and must occasionally be replaced. The high price of magnesite bricks, beginning in 1914, has decreased their popularity.

For end discharge, the hearths of continuous furnaces are frequently built with water cooled pipe skids all of the way through the furnace. The water cooled pipe is a necessary evil with the emphasis more on the evil than on the necessary, because the evil part of the water cooled skids lies not only in their heat absorption (which always entails a loss in furnace efficiency) but also in the black spots which they produce in the billets, to say nothing of the dangers arising from a leak in one of the pipes. Designs without water cooling will doubtless be developed in the future. The plain ordinary pipe skid cools much more energetically than necessary, because steel retains a great deal of strength up to 1,300 and 1,400 degrees F. Designs have therefore been developed to keep the water some distance away from the wearing surface so as to allow the latter to attain the above given temperature. Devices of that sort are shown in Fig. 147 (Alexander Laughlin & Co.), and in Fig. 148 (General Combustion Company). The former illustration represents an ordinary pipe which has been so deformed as to present a greater distance or mass of steel between the wearing surface and the water. The latter illustration, Fig. 148, shows a removable steel tongue held in a water cooled frame. This construction is preferable to the one of Fig. 147 in furnaces which receive heat from above only, but seriously weakens the hearth ridges of furnaces working with split flame. Water cooled skids are, as before mentioned, merely an incident in furnace development and will, in the writer's opinion, finally be replaced by alloy steels.

TO INGOT MOLD MAKERS AND STEEL MAKERS.

Steel scrap is and always has been cheaper than pig iron, and small steel scrap such as turnings, etc., very much cheaper still. If turnings are crushed, mixed with a little tar, lime and carbide of silicon, placed in old tins and baked at a black heat, blocks or briquettes are formed, which are easily melted down in a cupola, and with a suitable proportion of each ingredient will give a suitable iron for casting into ingot molds, or if desired, a load may be melted down in cupola of half broken ingot molds and half such synthetic briquettes. I have melted these down both in the cupola and in pots and remarkable is the fact that the sulphur is the same which ever way it is melted, which must be ascribed to the fact of using a little slaked lime in the mixture; the silicons were also very close and the fractures ideal for ingot molds, being very grey and open. The carbide of silicon is one of the products of the Niagara Falls Electrical Company, making carborundum, and I am informed the amorphous carbide of silicon is a waste product therefrom.

A process of this kind does not necessarily suit all ingot mold foundries but should suit all those who can get sufficient supplies of turnings and small scrap, and has the advantage of being simple as well as cheap.

For steel makers using the open hearth basic furnace, it is not necessary to use any carbide of silicon, and it is an easy matter to arrange to have a small bath of molten scrap remaining from previous heat, completely carborizing with baked blocks or otherwise and then charging any suitable scrap to bring down the whole to the carbon desired, a little manganese ore is desirable as part of the charge or some slag from previous heats may be used as a substitute.

Chemistry of Fuels Used in Steel Plants

Discussion Showing the Chemical Properties of the Better Known Fuels Such as Natural Gas, Artificial Gas, By-Products Gas, Tar and Fuel Oil as It Is Used in Steel Plants.

THE many advantages possessed by gaseous fuels make them ideal for many purposes. Owing to their gaseous state, they require no labor in handling, and their freedom from foreign matter eliminates ash and danger of contamination. As the temperature is easily controlled, and the flame can be directed wherever desired, the working conditions of a furnace may be kept uniform. The kindling temperature of gases is between 650 degrees C. and 700 degrees C. and the speed of combustion is practically instantaneous at that point, which fact makes it easy to attain very high temperature. In the following discussion the chemistry of most important fuels is outlined.

Chemistry of Natural Gas.

In the oil regions of Pennsylvania, Ohio and adjoining states, natural gas issues from the strata at a depth of 2,000 to 2,500 feet below the surface. Holes are bored and pipes sunk to the accumulated gas; it rises under a varying pressure, sometimes as high as 1,000 pounds per square inch.

Natural gas may be divided into two great classes:

1. A so-called "dry gas," known and used for many years as the natural gas of commerce.

2. A gas containing easily liquefiable vapors, which is known in the vicinity of the oil fields as a "wet gas."

The latter class forms the basis for the so-called "natural gasoline" industry, being composed of the paraffine group, or better known as saturated hydrocarbons, such as methane, ethane, propane, butane, etc.

The natural gas being used in the open hearth furnaces is composed of the following:

Methane, approximately	83.0%
Ethane, approximately	16.4%
Nitrogen, approximately	.6%
CO_2	None
CO	None

Natural gas does not contain carbon dioxide, carbon monoxide, or oxygen.

When this gas was first used in the open hearth furnaces, it was preheated before entering the furnaces, but owing to the hydro-carbons being decomposed, and the carbon forming hard, glassy coke in the chambers, the preheating was done away with. The gas is now introduced directly from the supply main with the ports of the furnace. Owing to its high calorific value and being free from sulphur, it is the ideal fuel for an open hearth furnace, and is generally used when it can be had.

The gas contains approximately 1,200 Btu per cubic foot. It requires about 5,000,000 to 6,000,000 Btu to produce one long ton of steel in the open hearth furnace when cold metal and scrap are used. Therefore, it should require about 4,377 cubic feet of natural gas to produce one long ton of open hearth steel.

Natural gas requires about 10 cubic feet of air for perfect combustion. In order to keep away from reactions, it has been thought advisable to give the above, but if you wish to obtain this data, refer to the "Principles of Combustion in the Steam Boiler," by Arthur D. Pratt. The volumes of oxygen and air required for combustion are there shown.

Artificial Gas—Producer Gas.

Producer gas is made from coal. The volatile products come from decomposition of the materials that the coal contains.

Coal, decomposed by heat, yields certain hydrocarbons that exist at ordinary temperatures as both liquids and gases.

Just as soon as any one of the various substances composing the primary volatile is evolved in a fire, it can follow one of the several routes of disposal. The route taken by any constituent will depend on existing environment, including chemical associations, so that in order that a good grade of gas will be made in the producer, attention must be paid to the building up of the coal bed as well as the air supply.

A modern producer consists essentially of a vertical steel cylinder of from 8 feet to 12 feet in diameter and 10 to 15 feet in height. This is lined with firebrick. At the bottom is a grate on which is supported the mass or fuel about 6 to 7 feet in depth.

From the top of this producer a duct leads to the main gas flue, and at the base are openings for the admission of steam and air blasts. The bed of coal being ignited, a blast of air mixed with a slight volume of steam is introduced.

The carbon of the coal brought in contact with the air is burned to carbon dioxide, the major portion of which passes up through the bed of hot fuel; thus carbon monoxide is formed. A portion of the steam which is introduced at the same time is also decomposed in contact with the incandescent carbon, forming hydrogen and oxygen, the latter then forming with the carbon (carbo monoxide).

In addition to the above, there is distilled off a certain amount of the more volatile hydro-carbon from the upper portions of the coal bed. The object being to produce a good grade of gas that will meet the requirements of the open hearth department.

The following will show a fair average of producer gas:

Carbon dioxide	5.8
Illuminants	.2
Oxygen	None
Carbon monoxide	23.4
Methane	3.8
Hydrogen	10.6
Nitrogen	56.2
Btu per cubic foot	152.

One ton of bituminous coal will produce about 140,000 to 150,000 cubic feet of gas. Although a number of different fuels have been used in making producer gas, such as anthracite coal, coke, peat, etc., bituminous coal is the only one necessary to consider here.

A good grade of coal for gas manufacture will run as follows:

Volatile matter	34.00
Fixed carbon	56.00
Ash	10.00
Sulphur	.80

The coal should be an ordinary good coal. The major portion of the bituminous coals are satisfactory for use, provided they do not run too high in sulphur.

The coal should have a comparatively low percentage of ash. Other things being equal, the higher the percentage of volatile matter, the richer the gas produced.

On account of the greater proportion of hydro-carbons, a gas showing ample calorific efficiency can be manufactured from anthracite coal, but in actual operation it would be exceedingly unsatisfactory. This is due to the lack of hydro-carbons.

The object of the producer is, therefore, to convert the whole of the carbon in the coal into combustible gas, so that nothing is left but the ash, and this may be done by drawing air through a fairly thick bed of incandescent carbon, the carbon uniting with the oxygen of the air to form carbon monoxide, as shown by the following reaction:

$$C \div O_2 = CO_2$$

This CO_2 passing through a bed of red-hot carbon reacts on another atom of carbon, forming CO, thus $CO_2 \div C = CO$.

Fuel Oil.

There are two kinds of petroleum, one having the parafine base, the other an asphaltum base. Either may be used as a fuel in its crude state, but both are largely distilled to obtain the most volatile oils, such as gasoline, benzine, and kerosene. The residum is called fuel oil and can be used in every class of service where coal, coke or gas can be used.

It is proving a desirable fuel, because the fire can be kept under control and can attain and maintain the heat required at all times.

In burning liquid fuel, it is essential to use good judgment. The burning of oil is a science. It is first necessary to have a burner, scientifically constructed, that will atomize any gravity of liquid fuel purchasable in the open market, no matter whether the oil be volatile or heavy. The burner should be of such construction that it will not carbonize, but must attain and maintain the required temperature at the will of the operator.

The Government's requirements for fuel oil are:

Specific gravity, not below .97 to 15 degrees C.
Flash, not below 150 degrees F.
Sulphur, not above 1.00 per cent.

The oil used in the open hearth furnace will run about as follows:

Carbon	83.26%
Hydrogen	12.41
Oxygen	3.83
Sulphur	.55
Gravity at 15 degrees C., about	.926
Weight per gallon	7.3 lbs. to 7.7 lbs.
Btu per pound	18,000 to 131,400 per gal.

To figure the amount of air necessary to burn one gallon of the above fuel oil, we must know the weight of one gallon:

One gallon of water weighs	8.33 lbs.
Specific gravity of this oil is	.926

Therefore, one gallon of the oil will weigh 7.72 pounds and will require 109.23 pounds of air, or 14.15 pounds of air per pound of fuel.

Therefore, since 1,000 cubic feet of air at 62 degrees F. weighs 76.1 pounds at 14.7 pounds atmospheric pressure, so 1 pound would equal 1435.3 cubic feet.

Therefore, the amount of air required per one gallon of the above oil would be 1435.3 cubic feet.

It has been shown, under open hearth practice, that to produce one long ton of steel, it requires about 5,000,000 to 6,000,000 Btu. Therefore, to produce one ton of steel from fuel oil of the above composition, it would require approximately 43 gallons.

Tar.

Tar makes a very good open hearth fuel, if it can be had in sufficient quantities at a reasonable price.

Properties of a high hydrogen content is desirable; it indicates the presence of aliphatic hydrogensons, meaning that it applies to compounds having open structure, derived from fatty acids. Hydro-carbons facilitate ignition. A moderately low viscosity is desirable, as the tar must be sufficiently mobile, or thin, to flow through the pipes in cold weather.

It should not contain more than 2 per cent water, as this will cause the tar not to ignite at the proper temperature.

The ash content should not exceed .15 per cent.

Average Analysis of Tar.

Carbon	90.1%
Hydrogen	6.8
Oxygen and Nitrogen	2.4
Sulphur	.5 to .9
Water	1.0 to 2.0
Specific gravity	1.6 to 1.2 at 62 degrees F.
Btu per pound, about	16,260
Btu per gallon, about	162,600
Weight per gallon	8 lbs. to 10 lbs.
Flash point	370 degrees F.

The amount of air required for combustion can be calculated, shown under fuel oil. It requires about 35 gallons of tar to produce one ton of steel, using the tar under the same conditions as explained under open hearth practice.

By-Product Gas From Coke Ovens.

By-product gas will, in the future, be used more and more in the production of open hearth steel. This is being brought about by a legislative action compelling many steel works to discontinue the use of natural gas, the most convenient fuel.

Therefore, matters are different with coke oven gas, as a fuel for open hearth furnace. It will require considerable research work before this fuel can be used satisfactory. The gas contains a very high percentage of hydrogen, and is therefore very light, so has a tendency to burn out the roof of the furnace. But arrangements will be made through time to take care of this grade of fuel. It should make an ideal fuel, which can be used instead of natural gas.

(Continued on page 457

Design of Experimental Rolling Mills

Description of Details of the Design of the Experimental Mill of Bureau of Rolling Mill Research—General Features of the Different Types of Mills When They Are Assembled.

By W. B. SKINKLE,
Director, Bureau of Rolling Mill Research.

PART III.

BEFORE proceeding with the detailed assemblies of the various types of mills into which the three sets of housings may be assembled it would be advisable to consider carefully the design of the housings themselves and the stresses resulting from the loads that are applied.

In this connection the author believes the work of J. D. Keller stands out pre-eminent as the most careful and logical set of investigations along this line that have been carried out to date. The complete report on Mr. Keller's work is on file at the Carnegie Institute of Technology and is nearly 50 pages long. An abstract of this report was printed in the August 1917, issue of THE BLAST FURNACE AND STEEL PLANT.

Briefly, Mr. Keller attacked the problem along the following lines.

There is a remarkable similarity between the stress-strain in curve of rubber and cast iron. A study of Fig. 17 will show this fact. Note, that like cast iron, the stress-strain of rubber is a flat curve and not a straight line. That for a very short distance the strain is proportional to the stress and that as the load increases the strain increases more rapidly than the stress.

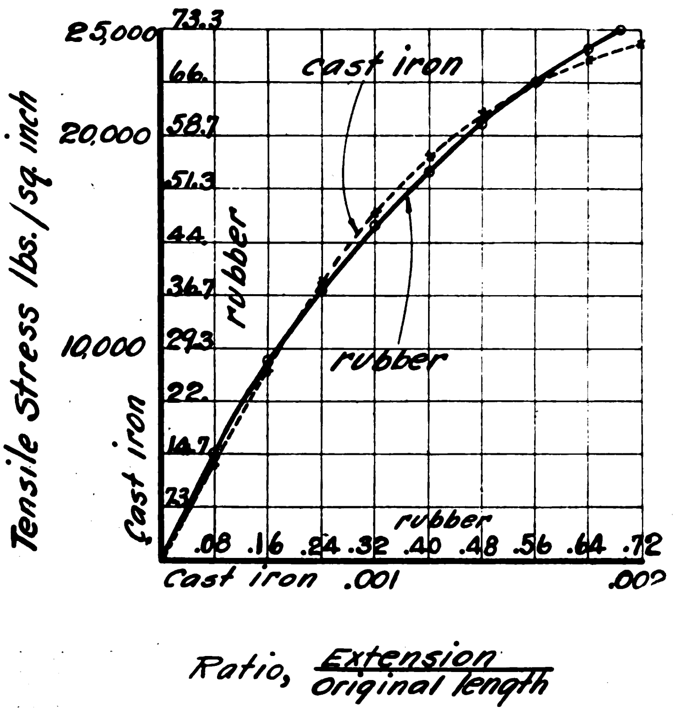

Fig. 17.

A rubber roll housing was made to a scale of 1 inch equal to 1 foot, which, with the exception of several very minor details, was an exact model of a standard sheet mill housing in very general use. Careful experiments developed the fact that a load of 63.6 pounds placed on the model would produce the greatest distortion of rubber allowable, as from this point on the variation between the stress-strain curves of the two materials became disproportional.

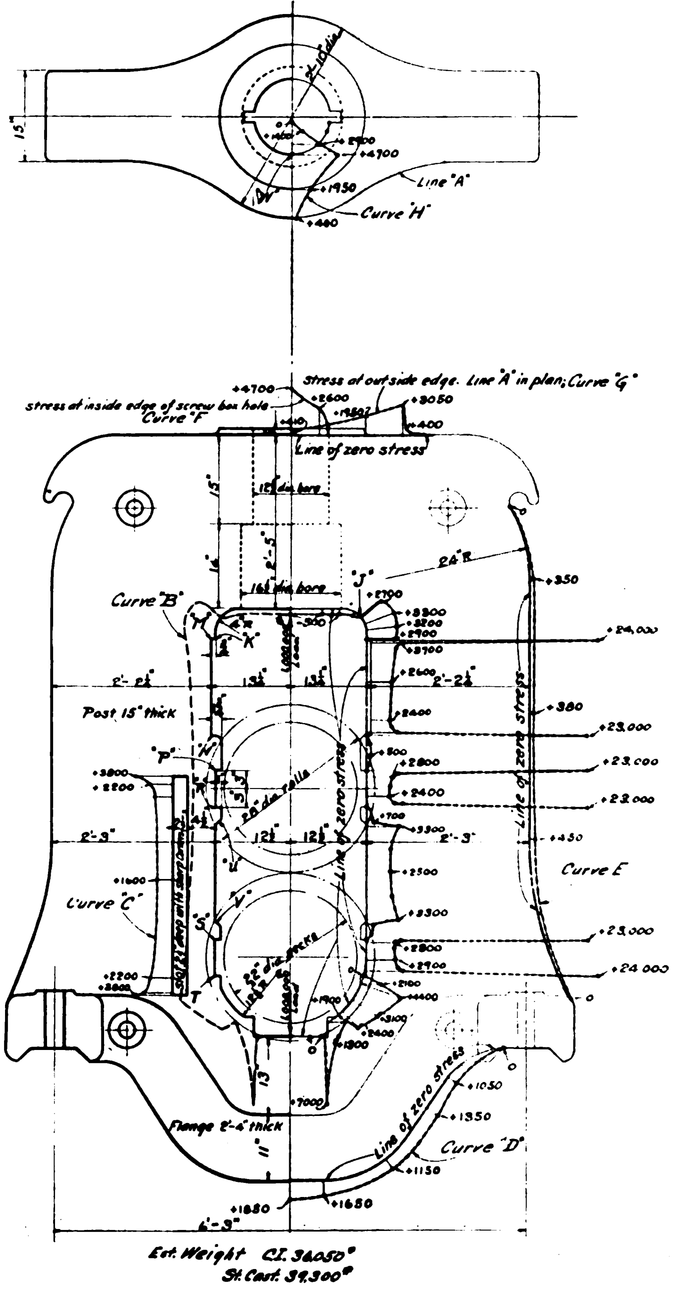

Fig. 20.

The rubber model was then ruled into small rectangles over one-half of its surface and photographed in its no stress condition. The load of 63.6 pounds was then applied in such a manner that it represented the separating force of the rolls.

The housings in its stressed condition was again photographed. The camera was not moved between these operations. The plates of these photographs were then set up and examined under a micrometer microscope and the change in length of each line measured. These changes in length were referred back to the curves, and figured back into the fiber stress that would exist in a sheet mill housing when resisting a separating force of 1,000,000 pounds. It is believed that the load on the housings of a 28-inch sheet mill frequently reaches this amount but does not exceed it.

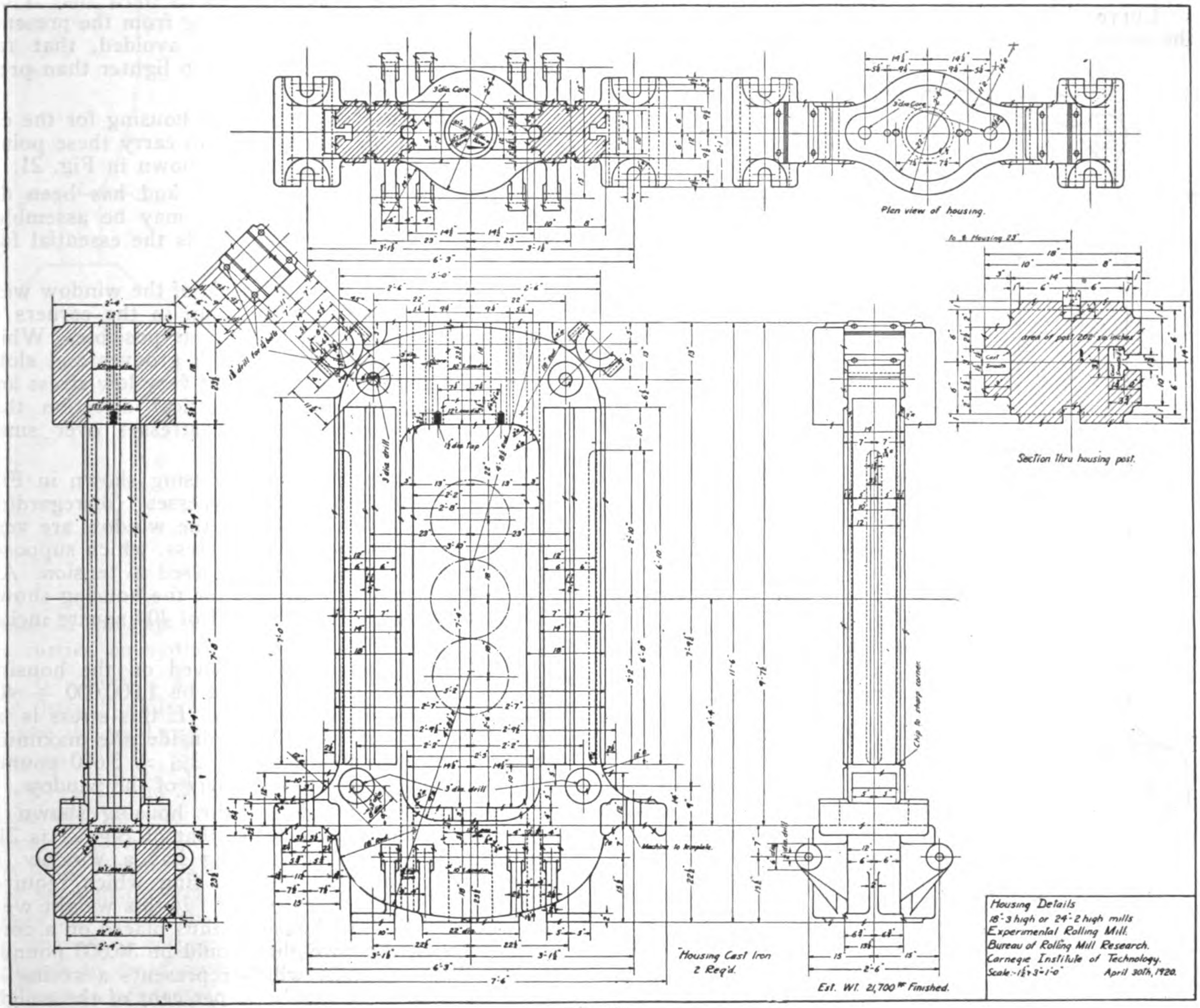
Plan view of housing.
Section thru housing post.
Housing Cast Iron
2 Req'd.
Est. Wt. 21,700# Finished.
Housing Details
18"-3 high or 24"-2 high mills
Experimental Rolling Mill.
Bureau of Rolling Mill Research.
Carnegie Institute of Technology.
Scale:-1½"=3"=1'-0"
April 30th, 1920.

Fig. 21.

The results are somewhat surprising and illustrate very strikingly the evil effects of sharp corners and sudden changes in cross section areas.

Fig. 20 shows a drawing of this housing, the left half of which is in heavy lines and the right half in light lines with the stresses plotted just where they occur.

From the top of the window at the center line we note that there is a compressive fiber stress of 500 pounds per square inch; this remains nearly constant, dropping off to zero about the middle of the radius as shown at point "J" and rising very sharply to 2,700 pounds tension, which increases slightly as the radius is followed; dropping suddenly to zero when the point "K" is reached. At the inside corner "M" which has been machined to a sharp corner the stress rises suddenly to a maximum of + 24,000 pounds per square inch. This drops very rapidly to a value of + 2,900 and then gradually to + 2,400 when the second sharp corner "N" is approached. The stress in this corner rises to another maximum of + 23,000 pounds per square inch. The sharp corners "P" "R" "S" and "T" show similar jumps in the tensile stress whereas the filleted corners "U" and "V," while showing some slight increases are not nearly so marked. The curve "B" on the right hand side of the housing shows the fiber stresses that would have been developed if the sharp corners had been omitted. It represents a plot of the points filled in solid black on the curves on the right hand side of the figure.

The light lines from the plot points to the line of zero stress show the direction in which the values were measured. When curved surfaces were encountered, as near the top and bottom of the windows, these measurements were taken radially.

The curve "C" on the left half of the housing shows the stresses occuring at the edge of the slot. While this stress rises to a maximum of over double its average value along the slot, it is not sufficiently large to be considered dangerous.

Curve "D" shows the tensile stresses existing along the bottom of the housing while curve "E" shows the stresses occuring at the outside edge. It will be noted that this last mentioned curve shows a very low stress on the outside edge, the stress ranging from zero at the feet and lifting lug, to a maximum of + 450 near the middle of the housing post.

Curve "F" shows the stresses at the inner edge of the screw hole at the top of the housing. Note that the maximum stress of + 4,700 pounds per square inch occurs at the inner edge of the screw box hole at the center of the housing at the point marked "W" in the plan view. The curve "H" shows the distribution of the stresses around the edge of the screw box hole and across the section of the housing at the center line.

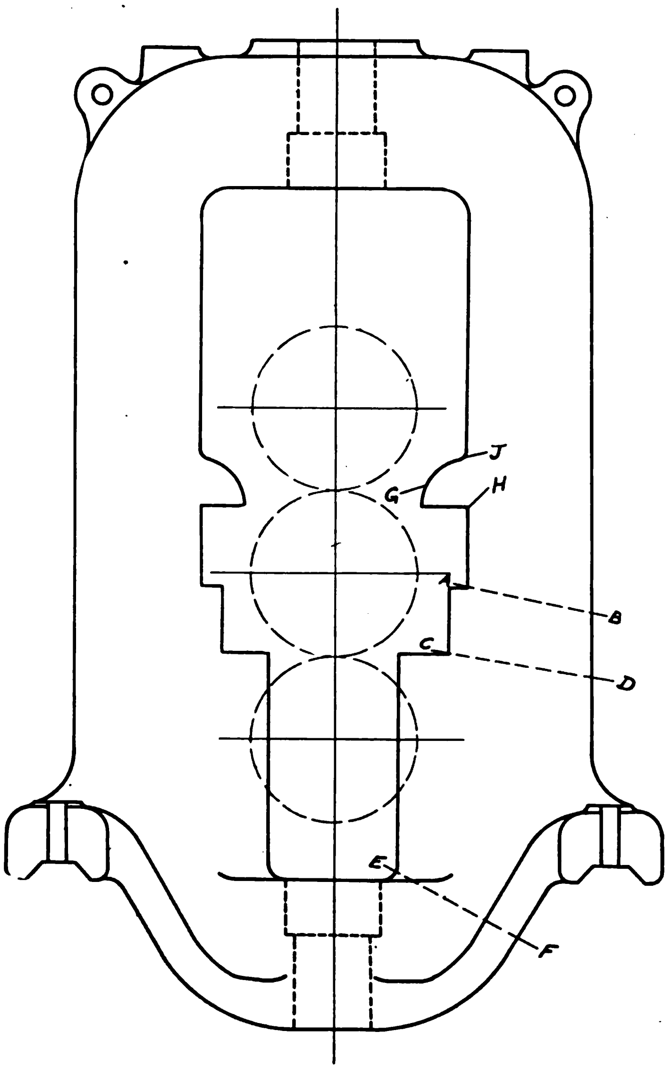

Fig. 22.

This curve develops the fact that an increase in the diameter of the metal surrounding the screw box adds very little to the strength. The metal at the outside of the swelling carries only + 410 pounds per square inch as against + 4,700 pounds per square inch at the inner edge of the screw box hole.

Curve "G" shows the distribution of stresses along the edge of housing (indicated as line "A" of the plan view).

Note that the stress rises as the swelling for the screw box decreases and comes more nearly in line with the edge of the screw box hole.

Disregarding the sharp corners and their resulting high fiber stresses this investigation seems to show three points of weakness at each end of a properly designed roll housing, viz.: the two corners of the window and through the center line of the housing.

The investigation also seems to show that if the points of maximum stress resulting from the presence of sharp corners were carefully avoided, that roll housings could be made very much lighter than present practice permits.

In his design of the large mill housing for the experimental mill the author tried to carry these points in mind and submits the design shown in Fig. 21.

While this housing is special and has been designed in such a manner that it may be assembled into several different types of mills the essential features are there.

All sharp corners on the inside of the window were very carefully avoided. The radii in the corners of the window were made as large as possible. While the housing is badly cut up with grooves and slots, these begin and end in sections of very low stress and have no irregularities in a vertical direction that would cause concentrations of stresses over small areas.

Curves for the sheet mill housing shown in Fig. 20 show that the maximum stresses (disregarding sharp corners) on the inside of the window are very close to 2¼ times the average stress, which supposes the whole post to be equally stressed in tension. Assuming this same ratio to hold for the housing shown in Fig. 21 we would have a total of 404 square inches of cast iron carrying the load.

If 1,000,000 pounds were placed on the housing the average tensile stress would be 1,000,000 ÷ 404 = 2,480 pounds per square inch. If this stress is increased by the factor 2¼ at the inside, the maximum tensile stress would be 2,480 × 2¼ = 5,600 pounds per square inch at the four corners of the window.

The estimated weight of the housing shown in Fig. 20 is 36,050 pounds, while that of Fig. 21 is 21,700 pounds. This last housing has a window 17 inches longer than the first housing which requires 1,800 pounds of additional metal. If this weight were deducted and the two housings thus placed on a comparative basis, their weights would be 36,000 pounds, against 19,900 pounds, which represents a saving of 16,100 pounds, or of nearly 45 per cent of the weight of the large housing.

While this saving may be permissible as far as the strength of the roll housing is concerned the question of stiffness would be a large factor in sheet mill design. There can be no question about the greater stretch of the light housing post.

There are, however, many types of mills such as plate mills, blooming mills, and bar mills, where rigidity is not a factor.

The points developed in this article could be used in the design of housings of this type to great advantage. The stretching factor would be of import-

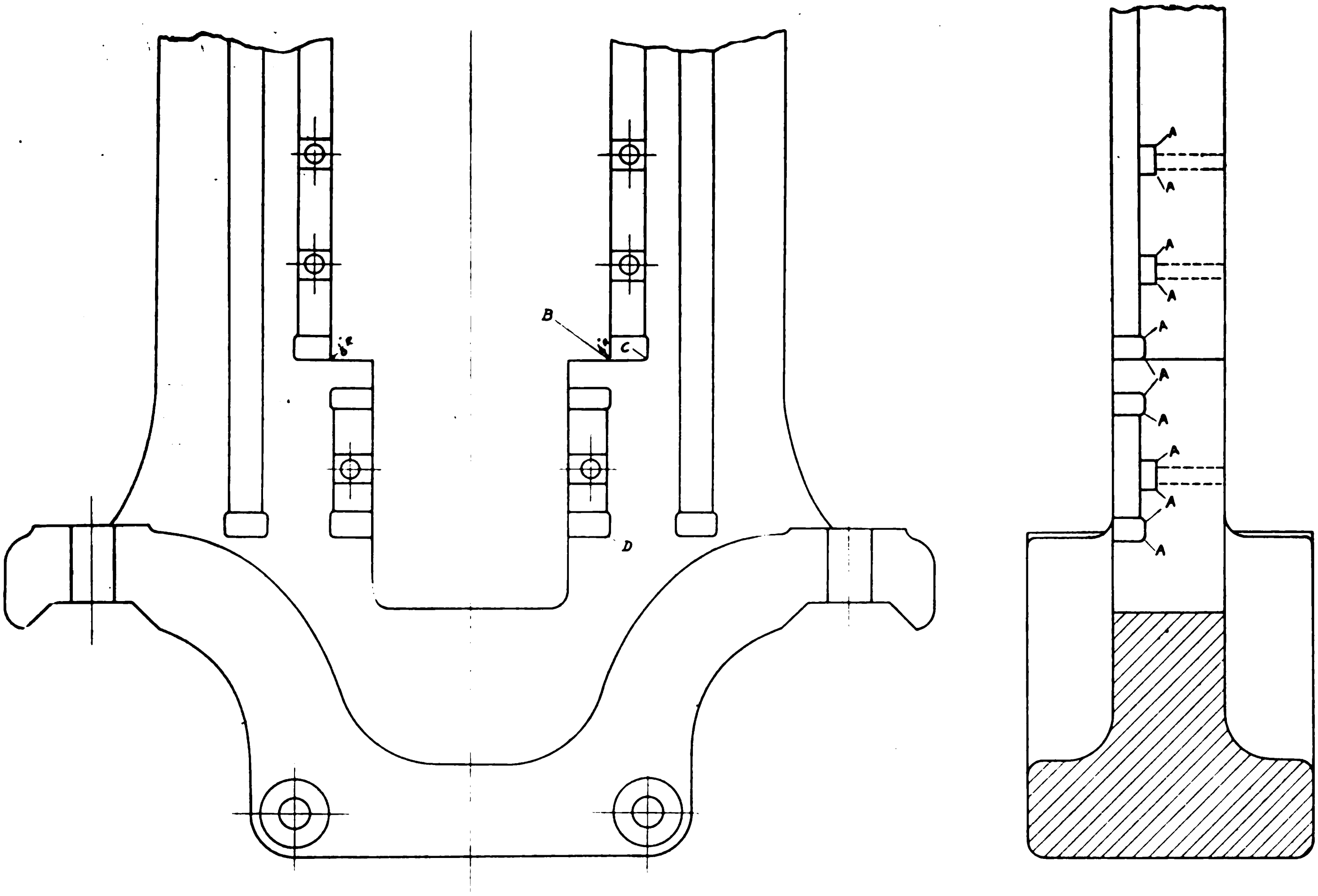

Fig. 23.

ance in the experimental mill because the lower roll is carried on hydraulic support cylinders.

It would be a simple matter to raise the pressure in these cylinders until it was sufficiently large to make the final pressure put on the sheets the correct amount.

Figs. 22 and 23 are taken from actual 18-inch mill housings now in operation, and in the light of the foregoing discussion show several very bad features in their design. The weak sections in Fig. 22 would be through the top screw box or the sections A B, C D or E F. The sharp corners at A and C, particularly the sharp corner C, where there is a very radical change in cross section, will cause a very high concentration of stresses. While the lug G will cause an increase of stress at corners H and J, they will not be serious because the lug G is so short.

In Fig. 23, the corners B C and D will cause very heavy concentrations of stress. There will also be very noticeable incurments at the corners A. One very good feature of this design is the very heavy flange on the bottom of the housing. This heavy flange will increase the stiffness of the bottom and cause a more even distribution of stress across the posts. If the bottom and top of a roll housing could be made infinitely stiff, the distribution of stresses across the posts would be uniform.

Now that the design and purposes of the roll housing has been discussed at some length, the next installment will consider the details of the various mills into which this housing may be assembled.

(Continued from page 453)

By preheating air alone to 1,100 to 1,150 degrees F., flame temperatures of over 3,500 degrees F. can be obtained. This should make by-product gas a very valuable fuel, providing the refractories used in the furnace can be made to withstand this high degree of temperature.

Average Analysis of By-Products Gas.

Hydrogen sulphide	.6%
Carbon dioxide	1.6
Ethylene	2.1
Oxygen	.5
Carbon monoxide	1.9
Hydrogen	47.6
Methane	32.3
Nitrogen	13.4
Specific gravity	.42
Btu per cubic foot	522

It will therefore require approximately 10,902 cubic feet to produce one long ton of steel under the conditions explained in open hearth practice.

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Electricity in a Large Modern Steel Plant

An Analysis of the Application of Electricity Throughout the Entire Process of Iron and Steel Production—Details of Electrical Apparatus at the Maryland Plant of the Bethlehem Steel Company.

By R. B. GERHARDT.

PART II.

The bloom and rail mills are the old original mills of Sparrow's Point. The bloomer is a 36" two high reversing mill, driven by a 42"x60" twin engine, and the rail mill is a 26" three-high mill, built in three stands. The one roughing stand is driven by a 36" and 66"x 66" Porter Allen engine, and the one intermediate and one finishing stands are driven by a similar engine. Blooming and rail mill engines are operated condensing on a Weiss barometric condenser. There is a boiler plant for supply steam for these engines located adjacent to the mill, and contains 20 boilers each rated at 250 bhp, and arranged for oil firing. Steam-driven hydraulic pumps for taking care of manipulators, shears, table lifts, transfers, etc., are located in a pump house near the boilers, and this building also contains a fresh water pumping plant and boiler feed pumps. The blooming mill screw-down and all tables, straighteners, saws, drills and finishing machines are motor-driven. The crane equipment consists of one duplex stripper, three soaking pit cranes, two mill cranes, one yard gantry, three single leg gantry rail loading magnet cranes and one roll shop crane. There are two narrow gauge electric motor cars for handling ingots from the strippers to the soaking pits. A continuous reheating furnace forms a part of the rail mill equipment, and all auxiliaries used with this furnace are electrically driven. The total number of motors in this department is 136, representing 5,190 hp.

Bloom, Billet and Bar Mills.

These mills are located in one building and arranged so that billets, slabs and sheet bar can be rolled direct from ingots. The heats from the open hearth are transported over a 3-foot gauge road to the 200-ton electric strippers by steam locomotive. After stripping they are weighed and shifted into the soaking pit building which contains six rows, four furnaces per row of producer gas-fired soaking pits with electric-operated covers. Here two 10-ton ram type soaking pit cranes charge the ingots into the pits and draw them again when they have reached a rolling temperature, delivering them on to an electric ingot buggy which transports them to the blooming mill approach tables, where a hydraulic cylinder dumps the pot containing the ingot, and it is delivered on the table.

There are two sections to the mill approach table, the first controlled by the ingot car operator and the second by the roller. Each section is driven by a 55 hp motor. The front and back mill tables are each made up of 21 rollers 18" diameter, spaced 27" centers, and each table is driven by a 150 hp engine type motor having a normal speed of 100 rpm. On the mill screw-down there are two 100 hp motors, and the side guards which are installed with manipulator fingers on front and back table are driven by four 75 hp motors, with two 75 hp motors on each set of fingers.

The blooming mill is a 40" Mesta mill, driven by a General Electric, 500 hp dc reversing motor equipment, which consists essentially of two 2,500 hp motors, mounted on one common shaft, each motor being supplied with energy from a 2,000 kw, 600 volt, dc generator; the two generators form a part of a flywheel motor generator set, of which the remaining parts are one 3,000 hp, 6,600-volt, 375 rpm induction motor for driving the set, and one 50-ton flywheel for taking care of the peak loads and preventing same from being reflected back on the electrical system. A separate motor-driven exciter supplies current for motor and generator fields.

The speed range of the motor is from 0 to 120 rpm in each direction. An air conditioning plant is used in connection with a blower for providing forced ventilation for the motor, and a liquid slip regulator is used for controlling the motor driving the flywheel set.

In the blooming mill 21"x43" ingots, weighing 16,500 pounds, are rolled down to 9"x38" slab sections in 16 passes. The average power consumption for this operation is 10.4 kw hours per ton of finished slabs. This figure represents records taken over an extended period of operation and covers idle running of the flywheel set and auxiliaries while no steel was rolled. The steel is then carried over tables and a broadside transfer and sheared in an 800-ton steam hydraulic shear into slabs, which are loaded on narrow gauge trucks and shipped hot to the plate mills. Ingots 21"x33", weighing 12,000 pounds, are rolled down to 8"x8" blooms in 20 passes, carried over connecting tables, cropped in a 500-ton upcut shear and cut to proper lengths for rolling into billets or bars.

The average power consumption over an extended period is 20.8 kw hours per ton of finished blooms. Figs. 3 and 4 show the load curves for rolling one ingot into 8"x8" blooms.

Beyond the broadside transfer there is a roller table which delivers the blooms to a six-stand 24" Morgan continuous mill, where they are rolled down to 4"x4" billets or 8"x2" slabs. The billets are taken from the 24" mill delivery table, over a broadside transfer, to a roller run and delivered to a 500-ton steam hydraulic shear, and sheared into shipping sizes. If short billets are required they drop into a conveyor under this shear and are delivered into bins and cooled in the yard for shipment. Long billets pass over cooling beds beyond the shear and are loaded by crane for shipment.

The 8"x2" slabs, from the 24" mill, pass over a connecting table and through a six-stand 18" Morgan continuous mill, where they are rolled into sheet bar. Beyond this mill there is a flying shear for cutting the bar into proper lengths, and a bar piler for piling them ready to be handled to the cooling beds.

The 24" mill is driven by a General Electric 4,000 hp, 6,600-volt, 3-phase, 25-cycle, 83.3 rpm wound rotor induction motor connected directly to main mill driving shaft. The power consumption of the 24" mill averages 9.55 kwh per ton of finished billets, and Fig. 5 is a graphic chart showing the rolling of a 4"x4" billet.

The 18" mill is driven by a General Electric, 3,250 hp motor, 94 rpm; 26.8 kw hours per ton of finished sheet bar is the average power consumption of this mill, and Fig. 6 is a typical load chart.

All of the main roll-driving motors are housed in a motor room separated from the mill proper and running almost the entire length of the mill building. In this room is also located all the magnetic control equipment for the mill, an air compressor and fresh pumping plant, as well as a sub-station which comprises two 1,000 kw motor generator sets and a 1,200 kva transformer bank for furnishing 250-volt, dc, and 550-volt, 3-phase, ac power for the mill and auxiliaries. Fig. 7 shows a view looking down this motor room.

In the blooming, billet and bar mill layout, including a roll shop, there are two 200-ton stripper cranes, two 10-ton soaking pit cranes and 13 miscellaneous cranes. There are 181 motors in this department, totaling 18,474 hp.

36"x110" Sheared Plate Mill.

Slabs or ingots, weighing 3,000 to 9,000 pounds are loaded on narrow gauge trucks by one of three electric cranes in the slab yard, to make up the heats. These trucks are handled by narrow gauge shifter into heating furnace section of the mill where slabs are charged by means of special electric slab handling or charging cranes into stationary gas-heated furnaces, of which there are six, each having four electrically-operated doors and electrical gas-reversing equipment. Hot slabs or ingots are taken from these furnaces by the charging cranes and dropped on an ingot car, operated by cable from an electric winch, which delivers them on the mill approach table from which they are in turn delivered to the mill proper for rolling. The distinguishing feature about the drives on the mill auxiliaries is that front live table, back live table, lifting table and middle roll balance are all motor driven by 150 hp, 230-volt, dc, slow speed, engine type motors, the normal full load speed of each being 100 rpm. The mill itself is a Mesta three-high 36"x110" mill, and is driven by a General Electric 4,000 hp slip ring motor; 6,600-volts, 3-phase, 25-cycle, 83.3 rpm connected direct to the leading spindle. Fig. 8 is a load chart taken during the process of rolling a 6"x38" slab down to a ½"x84" plate. The screwdown is operated by two 75 hp, mill type motors connected permanently in series. Manipulation of the slabs is done by hand.

After the piece is rolled down to a plate it passes over a connecting table to the straightening machine which is driven by a 200 hp motor shunt wound. From the straightener it passes over a connecting table to the inspection table, where it can be edged up or turned completely upside down as desired, by means of five 55 hp motors. Next the plate passes to the laying-out tables and from thence to the cross-cut hydraulic shear. From this point it is handled on castors by hand to the longitudinal hydraulic shears, then weighed and pushed by hand onto distributing conveyors from which it is discharged by means of kick-offs onto piles, to be loaded by one of three shipping cranes into cars.

The hydraulic power for the cross-cut shears and two longitudinal shears, as well as for the shears in the other mills, is obtained from three high pressure pumps, each driven by a 350 hp, 3-phase, 25-cycle, 550-volt, slip ring induction motor.

Coal gas is used in the heating furnaces, and this gas is made in producers, each driven by a 5 hp slip ring induction motor. Features worthy of note in the gas house are an automatic coal skip for handling coal from pocket under railway track up to bins, also a scale larry car for distributing coal to the producers, and an electric telpher car for handling ashes from the poducers. A similar telpher is also used in the heating furnace building for handling cinder from the furnaces into railway cars.

Miscellaneous equipment covers 50-ton crane over the mill, with 15-ton auxiliary hoist, 5-ton scale crane, electric-driven chariot for changing the middle roll, slow speed device with mill type motor for turning up rolls while in the mill, a roll turning lathe, two motor-driven scrap shears, a circular shear, and a knife grinder, and a 75-hp motor-driven air compressor.

The total number of motors for the mill and gas producers, including all cranes, is 122, representing a connected load of 8,653 hp.

The power consumption on the main motor averages 21.0 kw hours per ton of slabs, and on the total mill 44 kw hours per ton slabs rolled. Average slabs rolled are 6"x38"—4,000 pounds. Finished plates average ½"x72".

60" Universal Plate Mill.

This mill is still under construction, but it is fast nearing completion and will probably go into operation very shortly. The heating furnace arrangement is exactly similar to that of the 110" plate mill; but on account of the longer plates rolled, the ingot buggy in this mill delivers the slabs along the side of the mill approach table and they are pushed on to table with an electric pusher. The front and back live tables each consist of 22 rollers, 16" diameter mounted 27" from center to center. Each table is driven by a Crocker-Wheeler Engine type motor rated 150 hp, at 100 rpm. The mill proper was built by the Morgan Engineering Company, and is a 60" two-high reversing mill, designed to roll a 62"x13"—10,000 pound slab down to ⅜"x60" plate in 21 passes. The body of the horizontal rolls in contact with the slab is 36" diameter, and that of vertical rolls is 21" diameter. Maximum speed of horizontal rolls is 100 rpm, and of vertical rolls is 180 rpm. The screwdown is driven by two 80 hp mill type motors, and each pair of vertical rolls is adjusted with a 50 hp mill type motor. A Westinghouse reversing equipment is used for driving this mill, and consists of motor, flywheel, motor generator set, exciter, liquid slip regulator, switchboard and air conditioner. The motor unit consists of two armatures mounted on one shaft, which is supported from a heavy bed plate in two pedestal bearings. This bed plate also supports the two field frames. The maximum peak rating of this motor is 17,500 hp, and the speed range is from 0 to 100 rpm in each direction.

The flywheel set consists of two 3,000 kw, 700-volt, dc generators for supplying current to the main mill motors; one 5,000 hp, 6,600-volt, 3-phase, 25-cycle, 368 rpm, wound rotor motor for driving the set and one 75-ton flywheel, all mounted on a common bed plate.

The exciter is a 3-unit machine, and supplies field current for mill motors and the dc generators. The liquid slip regulator is used for controlling the motor on flywheel set, and the switchboard handles current to each unit. The air conditioner washes the air used for ventilating the main motors.

The essential difference between this equipment and that on the 40" blooming mill drive is that this motor has the characteristics of a compound-wound machine, and the other has the characteristics of a shunt-wound machine.

The plate after rolling is complete passes through straightening rolls and over tables and transfers to the straighteners, from which point it passes on to the shears, is cut to proper sizes and delivered over additional tables to the shipping section of the mill.

There are 10 electric cranes in this mill, 126 motors, totaling 10,128 hp, and a 1,000 kw motor generator set.

Sheet and Tin Plate Mills.

The sheet mills and tin plate mills are really two separate sets of mills, each in its own building, and each complete within itself, but by reason of location, similarity of product, common source of raw material and other local reasons they are treated under one head.

So-called "sheet bar" is delivered to the bar building on standard gauge railroad cars from the 18" bar mill previously mentioned, is here classified, stored, sheared as needed by two alligator shears, each driven by a 20 hp, dc shunt motor, and thence delivered to the furnaces by a 10-ton crane. This stock is hand-loaded onto furnace chargers, each driven by a 5 hp induction motor, and is withdrawn and rolled in the hot mills. The heating furnaces are coal-fired, by reciprocating stokers, all stokers for one roll stand being driven through a line shaft by a 15 hp squirrel cage motor.

The hot rolls are arranged in four groups of six roll stands each. The two original groups have 28" rolls, and each group is driven by a Westinghouse 2,300-volt, 1,200 hp, 244 rpm wound rotor induction motor equipped with a double flywheel and liquid slip regulator, to reduce the peaks.

The latter two groups are driven by 1,000 hp, 6,600-volt, 245 rpm, General Electric wound rotor induction motors. Experience with the 1,200 hp motors indicated that 1,000 hp units would be sufficient for the new mills, but as a matter of reserve, air ducts, connected to the mill cooling system, were run into the foundations, and removable enclosing covers provided for the motors, so that forced ventilation can be applied to obtain higher ratings, should any changes require additional capacity. The new units have "notchback" relay control with standard grid resistors, in place of the liquid slip regulators. This type of control was chosen because of continual trouble with the liquid units, although they are now working fairly well with wood pots and large tank type coolers developed at Sparrow's Point.

The hot rolled product passes next through the squaring shears, each driven by a 5 hp squirrel cage motor, is weighed and sent to the "black" pickler, a steam-operated Mesta machine. Coming from the pickler it is packed in annealing boxes and handled to the furnace doors by a 25-ton crane. The boxes are pushed into, and later withdrawn from, the black annealing furnaces by a charger, the rack of which is operated by 11 hp induction motor.

Having been annealed the sheets are fed into the cold rolls, which comprise 21 roll stands, arranged in seven rows of three each, the three cross rows each driven by a large pulley through rope drives from a common pulley in the motor room. The common pulley is driven by a Westinghouse 1,200 hp, 366 rpm, 2,300-volt wound rotor induction motor, with notchback relay control, through a 39-tooth to 149-tooth Falk herringbone reduction gear.

The cold rolled sheets are again annealed, "white" pickled, passed to the tinning machines, the entire process being the same electrically as just described for the black sheets. The tinning machines are arranged in four groups of 10 each, for belt drive from a line shaft, each line shaft being driven by a 100 hp induction motor. Several storage battery tractors are in use for moving the truck loads of plate in the various departments.

The entire tin plate plant, including coal handling machinery, pumps, air compressors, etc., totals 5,441 hp in 116 motors, of which 21 motors, totaling 590 hp, are on the cranes.

The sheet mills comprise two sheet mills proper, one jobbing mill, one cold mill and auxiliaries. Each sheet mill consists of six roll stands, and is driven by 1,000 hp motors, duplicates of the new tin mill drives. The jobbing mill, of six stands of 30" rolls, is driven by a 1,150 hp motor, and is in every way similar to the sheet mill drives. This is also true of the cold mill, except that this mill, of four stands of 26" rolls, has only a 500 hp motor.

The control boards for all motors, together with their resistors, are located on galleries in the mill substation where they are free from all the mill dirt.

The handling of the bars, up to pickling process, is identical with the tin plate practice, and practically the same machinery is involved. After this point the system differs, some plates going through the annealing and pickling process, and are galvanized and some are shipped back. The electrical equipment for all, except the main rolls, is practically all confined to small units, and light cranes, except a few mill type motors on chain conveyors and straightening rolls for handling the heavier products of the jobbing mill.

A thoroughly modern sub-station, taking power at 6,600-volts, and delivering power at 6,600-volts, for the main rolls, 550-volts ac for the constant duty drives, and 250-volts ac, for the cranes and cars, has been built with the mill.

The total connected hp is 6,070, made up by 96 units, 36 of which, totaling 1,203 hp, are in crane service.

Service Departments.

For supplying salt water service all over the plant a central pumping station was built several hundred feet from the shore line out in the bay. The building, which is steel and brick structure, provided with 10-ton crane, is located on reinforced concrete piles, and is of sufficient size to house six 30,000,000 gallon pumps. Three of these units are now installed and each is driven by a 1,200 hp, 3-phase, 25-cycle, 6,600-volt, wound rotor induction motor. Automatic control is provided on these motors so that they can be started or stopped by float switches on the water surge tower.

An iron and brass foundry forms another branch of the service department and here castings for all of the plant repair work, as well as for some of the Bethlehem shipyards, are taken care of. There are also, in this department, pattern and carpenter shops, a large machine shop, locomotive repair shop and car repair shop. In the foundry and these shops there are a total of 13 electric cranes and 136 motors, totaling 2,351 hp.

Electric Power System.

Electric energy for the plant will be supplied from two sources. Approximately 17,000 kw will be supplied from the Consolidated Elec. L. & P. Company, of Baltimore, over a double 26,000-volt, 3-phase, 25-cycle, line to No. 1 sub-station, where there are located three 7,500 kva transformers for stepping down to 6,600-volt for distribution through the plant. The new gas engine driven electric power station provides all other power for the plant, and for this purpose, at the present time, five 5,000 kva generators are being installed, each driven by a Bethlehem 47"x60" twin tandem gas engine. This station is a brick and steel structure with 50-ton crane covering the machinery. It is designed so that additions can readily be made to provide for an ultimate capacity of 100,000 kva.

Furnace gas is washed in static washers at each of the blast furnaces and passes on to the power house through a gas main where a further cleaning takes place in Theisen washers, which are driven by a 150 hp, ac slip ring motor, and located in one end of the power house building. From this point it is carried into the distributing main and to the gasometers at each engine. Exhaust gases from the engines are discharged into a tunnel running the length of the building and carried out through a stack at one end.

For handling engine jacket water, and cooling this water in spray ponds there is provided in the same end of the power house building with the Theisen washers a system of centrifugal motor-driven pumps, also motor-driven air compressors located here, provide air for starting the engines.

The electric auxiliaries include one 750 kw induction motor-driven exciter, two 1,350 kva booster type rotary converters, one bank of 6,600-volt to 550-volt power transformers, consisting of three single phase 1,700 kva units. With this equipment excitation is furnished for the generators, and auxiliary power is supplied the departments in the immediate vicinity of the power house; these departments including ore wharf, blast furnaces, and No. 2 open hearth. Two of the main generators are being provided with belt-driven exciters for emergency use, and excitation for all generators can be taken from either the regular exciter or the rotary converters.

In the station are located three galleries running the length of the building and arranged as follows: The bottom gallery carries two main buses, and one transfer bus, all located in concrete structures. The second gallery contains operator's room with bench board and instrument panels, as well as all oil switches and disconnecting switches. The third gallery contains all generator field rheostats, storage battery for handling engine ignition and oil switching and lightning arresters. A dc distributing switchboard is also mounted in the third gallery.

The distributing system shown in Fig. 10 consists of a 6,600-volt, 3-phase, double ring bus on which are located four switching towers with taps off to the principal sub-stations. The principal sub-stations are located at the 40" blooming mill, 60" universal plate mill, 110" plate mill, rail mill and coke ovens. Other stations at tin mills, sheet mills, sintering plant, shipyard, gas pumping plant and central pumping station are fed from one of the principal sub-stations. A portable sub-station consisting of a 400 kw rotary converter with necessary transformers and switching equipment mounted in a standard railway box car is used anywhere around the plant where the occasion requires.

The loops originate and end at the gas engine power station and energy from Baltimore is fed into the loops at No. 1 sub-station. All principal switching on the loops is designed with an ultimate capacity of 35,000 kva, and the line construction itself is about as heavy as is possible to install under present practice. Eighty-five foot steel towers, weighing 17,000 pounds and supporting 5 cross arms, and a working platform, carry this line around the plant. The lines consist of 1,000,000 circular mill double braid weatherproof cable carried on special cable top 33,000-volt insulators. At various strain points on the line, special double barrel strain insulators and clamps are used. The switching towers are the same height as the line towers, and carry all of the switching in a two-compartment two-floor house at the top of the tower. The two compartments are provided so that the switching on one loop is entirely independent of that on the other loop. The sub-stations connected to the ring bus are tied together by 3-phase, 550-volt, and dc 250-volt tie lines. There is a complete system of relays and automatic switches for the full protection of all the lines, and an independent telephone system connects each sub-station with the load dispatcher. The principal sub-stations carry auxiliary apparatus in the shape of motor generator sets for supplying 250-volt, dc power transformers, for supplying 550-volt, 3-phase power and single phase lighting transformers for supplying lighting to all of the territory in the vicinity of each station. In the main generating station there is provided lighting transformers for supplying the town lighting system with 2,300-volt, single phase, energy.

On the total electrical system there are connected 2,169 motors, representing 117,850 hp.

Electrical Organization.

The electrical organization is made up of two principal divisions, operating and construction. The operating end takes care of the operating and maintenance of all electrical equipment in all of the departments except the shipyard (which has a separate organization). There is also included the electrical repair division which embraces the electircal shop, with an organization of mechanics and electricians for handling all repairs connected with the electrical equipment, including cranes and motor cars. A new two-story modern shop, with ample floor space, equipped with elevator, crane and a full line of tools, houses this branch of the department.

The construction division takes care of all new construction work from designing on down to installing and starting up, of electrical apparatus.

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Welfare Work in the Steel Industry

Interesting Review of the Safety, Sanitary and Welfare Bureau's Work as It Is Carried on Among the Employes of the United States Steel Corporation and Its Subsidiary Companies.

By C. L. CLOSE,
United States Steel Corporation.

PART II.

DURING the summer months many picnics and outdoor social gatherings are held under the auspices of the subsidiary companies for the employes and their families. As a rule these picnics are held in amusement parks in the vicinity of the plant, and adequate provisions are made for transporting the people to and from the picnic grounds. These outings are attended by the company and plant officials, and there is good wholesome entertainment in the way of sports and field events in addition to a sumptuous repast which is provided by the entertainment committee. All expenses in connection with these outings are borne by the company.

At a safety first picnic and rally held at Olympia Park near Duquesne, Pa., on August 23, 1919, for the employes of the Duquesne Steel Works and their families, 20,000 people were in attendance. The following menu, served in cafeteria style, will give some idea of the amount of food required to feed the picnickers:

Ears of corn	20,000
Pounds of meat	4,700
Pounds of butter	600
Loaves of bread	1,000
Buns	15,000
Pounds of weiners	1,200
Gallons of beans	500
Barrels of pickles	2
Pounds of cheese	300
Gallons of ice cream	600
Gallons of coffee	2,000

Musical Organizations.

Often considerable musical ability is displayed by the workmen at the various plants, and wherever sufficient material is found, brass bands are organized and male chorus singing is encouraged; the equipment and maintenance of these organizations is mainly at the expense of the company. By this means, musical entertainment is provided at the lectures on safety, and at the other gatherings, and becomes an important and enjoyable feature of the community life.

The majority of the plants now have brass bands with full equipment and uniforms. In one location where a subsidiary company has several operations, the bands from the different plants are combined for special occasions. These combined bands represent over 100 musical instruments, and beside making a very showy appearance, both on parade and in the concert hall, they render very high class music under the direction of an able leader. The musicians are all steel workers, the bands consisting of men employed in various departments of the plant. The services of these musicians are purely voluntary, but when away from the plant to play in the band for entertainments, either at day or night performances, they are paid full wages. During the war these bands rendered very valuable services playing at rally meetings for the various Liberty Loan drives and on other occasions for patriotic services.

One of the notable musical organizations in the corporation is the Liberty Chorus, composed of employes from two plants of one of the western subsidiary companies. This chorus appeared 56 times for war activities, and during the Victory Loan Drive, made a special trip to New York to sing at meetings at the Carnegie Music Hall, on the steps of the sub-treasury building, and other places. On their trip to New York for these patriotic meetings these men paid their own expenses. In recognition of the excellent services which they rendered during the war, they were presented with a large silver loving cup.

Dental Clinics.

The first attempt at dental work among employes and their families was made by the Tennessee Coal, Iron & Railroad Co., in the fall of 1915, with the employment of a dental surgeon to care for the teeth of children in various schools maintained by the company. An inexpensive, portable, dental outfit, such as is used in the United States Army, was secured, and the dentist moved from place to place usually establishing his clinics in the dental dispensary closest to the school to be covered. During the school year of 1915-1916, the teeth of every child in the schools (both white and colored) were examined by the school dentist and any necessary dental work was performed—the total representing about 1,200 extractions and 3,000 cleanings. Unquestionably, the children were greatly benefitted in health and the work proved immensely popular. Definite instructions were issued that no dental work would be done for any child without the written permission from the parents, and during the entire school year, in not a single instance was permission refused.

With the beginning of the school term in 1916, a second dentist was engaged to assist in this work, and a tooth brush drill was established in every school. Each child, in both the white and colored schools, was required to furnish his own tooth brush and cup, these articles being on sale at our own commissaries at actual cost. Dust proof cabinets were placed in every school room for the storage of brushes and cups. The tooth brush drill is the opening exercise of every school every day and the average time required is 12 minutes. The drill is popular with the children and is one of the real events of the day.

Later dental clinics were established at other locations where the company has its operations, and regular office hours were designated—three days each week for white patients, and three for colored patients. An excellent equipment, comprising electric engines, fountain cuspidors, hydraulic chairs, electric sterilizers, first class dental cabinets and dental operating instruments of the highest grade, was provided for each clinic at a cost of $900 to

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Abstract from paper as read before the American Iron and Steel Institute.

$1,500 for each installation. A schedule of charges, averaging 50 per cent less than the charges made by city dentists, is posted in every dispensary. When an employe or a member of his dependent family applies for treatment at the dispensary, his mouth is examined by the dentist and an estimate made of the cost of the required work. Payments may be made in monthly installments if the employe so desires.

The dentists in charge of the clinics have been selected with care and are employed on a straight salary basis, their work being under the close supervision of the chief dentist and the superintendent of the health department. The success of this service has exceeded all expectations.

Stock Subscription Plan.

In January of each year, under a plan inaugurated in 1903, shares of stock of the United States Steel Corporation are offered to all employes upon easy and especially favorable terms, which involve benefits beyond those to the ordinary stockholders. The principal features of the plan are as follows:

The number of shares which can be subscribed for depends upon the salary of the employe, but it is relatively greater for the lower-paid man. The price of the stock is the prevailing market price or usually a little less. Payments: Minimum, $2 per share per month. Maximum that can be paid is 25 per cent of monthly earnings. A premium of $5 per annum for five years is paid on each share of stock purchased by employes under this plan. Non paid-up subscriptions may be cancelled and the money paid in is refunded to the employe with 5 per cent interest. Premiums are not paid to employes who cancel their subscriptions, sell their stock or leave the employ of the company, and the forfeited or unpaid premiums for all those except cancellations are kept in a fund and divided pro rata among the remaining shareholders under this plan at the end of the five year period.

If death occurs to an employe who has subscribed for stock and made payments under this plan, his estate receives the unpaid premiums for the full five year period and a pro rata share of the premiums undivided at the time of death.

On April 30, 1920, more than 40,000 employes were stockholders under this plan. Their aggregate holdings amounted to more than 186,600 shares of stock of a par value of $18,600,000. It is impossible to ascertain how many employes, in addition to those yet receiving the specific benefits that continue for five years, hold stock upon which these special benefits have ceased to be paid, but it is believed that their numbers would greatly increase the figures here given.

In January, 1920, employes of the United States Steel Corporation and the subsidiary companies were again offered the privilege of subscribing for shares of common stock of the corporation under substantially the same conditions and terms as those attached to the previous years' offerings, except that the price for the 1920 subscriptions was $106 per share. Up to the present date subscriptions have been received from a total of 66,311 employes for an aggregate number of 167,263 shares. This is the largest subscription received under any offer.

The subscriptions for 1916, 1917, 1918, 1919 and 1920 were as follows:

	Number of employes subscribing				
	1916	1917	1918	1919	1920
Employes receiving less than $800 per year..	7,288	3,253	1,920	1,473	584
Employes receiving $800 to $2,500 per year..	16,272	33,443	37,236	46,676	45,409
Employes receiving over $2,500 per year.....	1,583	2,556	4,621	13,175	20,318
Total	25,143	39,252	43,777	61,324	66,311

	Number of shares of stock				
	1916	1917	1918	1919	1920
Employes receiving less than 800 per year..	8,961	3,253	2,252	2,148	593
Employes receiving $800 to $2,500 per year..	31,952	52,680	72,856	101,764	92,900
Employes receiving over $2,500 per year.....	9,356	11,819	21,537	54,149	73,770
Total	50,269	67,752	96,645	158,061	167,263

Pensions.

The United States Steel and Carnegie Pension Fund was established in the year 1910, by the joint action of the corporation and Andrew Carnegie. Its purpose is the payment of pension to employes of old age, from the income of the fund. For this purpose, the corporation provided $8,000,000, which with the Carnegie Relief Fund of $4,000,000, created by Andrew Carnegie on March 12, 1901, makes a joint fund of $12,000,000. This fund is administered by a board of 12 trustees through a manager appointed by the board.

Its principal features are:

a Compulsory retirement for men of 70 years of age and for women at 60 years of age, after 25 years of service.

b Retirement at request of the employe or his employing officer after the age of 65 for men and 55 for women, after 25 years of service.

c Retirement by reason of permanent total incapacity, after 15 years of service.

d Pension basis—for each year of service, 1 per cent of the average monthly earnings for the last 10 years of service.

e Credit for service rendered to any of the plants of the subsidiary companies of the United States Steel Corporation or to the predecessors of such companies.

f Minimum pension, $12 per month; maximum pension, $100 per month.

The records of the pension plan on December 31, 1919, are as follows:

Total number of pensioners December 31. 1919—2940.
Number of pensions granted during year 1919—310.
Total amount of pensions paid during year 1919—$733.707.45.

Average age at which pensions were granted to retiring employes since the inauguration of the plan—65.64.

Average term of service rendered by such pensioners—30.22 years.

Education and Americanization.

For many years the companies have been carrying on educational work among their employes, including vocational training and apprenticeship classes The purposes are:

To increase the efficiency of the workmen by teaching the fundamental and the more advanced principles involved in their individual lines of work.

To increase the earning power of the pupils by guiding them along the paths of quicker and deeper reasoning which lead to positions of gradually increasing responsibility in all departments of the mill.

To promote and develop the happiness of the pupils not only in their daily work in the shops and mills, but in their home life as well by opening the door to a more thorough understanding of the meaning of life and work.

The courses are varied to meet the needs of every employe who is desirous of advancement, whether he is the graduate of a university or a man who has had no special school advantages. The teachers are men actively engaged in their respective lines, either in the mills or in the city. These men are selected because of their scholarship and broad practical experience in the branches they teach. The majority are assistants or foremen in the various departments of the mills, and, therefore, are personally acquainted with many of the students in their classes, which results in an increased mutual benefit. Actual mill problems are considered and studied in every step of the work as it is taken up in the prescribed courses, with the result that each pupil not only learns the principles involved in his own special line of work, but also those that must be understood before he is qualified for the position ahead.

The subsidiary companies of the steel corporation have exerted their efforts in endeavoring to educate and Americanize their foreign-born workers, and success is attending their efforts. If we would have a 100 per cent America, we must help the foreign-born laborer to improve the opportunities afforded him for education and training, so that through knowledge of the language and familiarity with the standards of living in this country, his conditions will be improved, and there will be awakened in him a respect and love for American ideals which will develop into strong loyalty toward his adopted country. This is especially true at this time when the question is a national problem of such vital importance.

The companies have distributed many thousands of copies of a booklet on "Guide for Applicants for Citizenship" in which the steps necessary to become naturalized are outlined, as well as other facts regarding the United States which prospective citizens should know. Some of the companies have included a question in their employment application questionaire, asking if it is the intention of the applicant to become naturalized. This is done for the purpose of ascertaining and assisting those who are desirous of becoming citizens. The first step in the educational work is the teaching of the English language. Classes are conducted by many of the companies either in rooms in the mill buildings or through coöperation of the local school authorities, in a school room on two or three evenings of each week. Frequently employes of the companies volunteer as teachers, and lessons begin with the pronunciation of names of the objects most familiar to the men in their daily work. These lessons are supplemented by posters and bulletins posted throughout the mills and mines of the companies. As their knowledge increases many of the men attend the local public night schools or Y. M. C. A. classes which are partially maintained by the company through contributions made at regular intervals; and when the course in English is completed many of the men are competent to take out first citizenship papers.

In one locality this Americanization work is carried on for the sole purpose of assisting the men to secure their naturalization papers. While the actual task is under the supervision of an Americanzation committee, our subsidiary companies in the vicinity contribute freely to the maintenance of the schools and teaching staff. The buildings, light, heat and janitor's services are furnished by the school board and everything possible is done to make the school attractive to the foreigner. The men are taught to read and write, and to insure their interest in the lessons they are encouraged to discuss daily events and to read the newspapers. When they have acquired a sufficient knowledge of English many of the men apply for first papers; and then they receive instructions to fit them to pass the government examinations for securing their final papers.

Among the women and children much of the Americanization work is in the hands of the visiting nurses. The work covers a wide field; but through the children's clubs and homemaking classes these nurses are given opportunities to inculcate American ideals in the minds of the boys and girls, and through them to reach the parents, who are glad and eager to learn from their American neighbors. At many of the practical housekeeping centers, classes are formed for the foreign-born women, where they are taught the proper care of their children and homes. Here they acquire some familiarity with the language as well as a knowledge of American standards of living.

Many different methods may be advocated for the Americanization of our foreign-born population, but no better method can be employed than the training of the public schools and the intelligent use of such other facilities as are already in existence in the industrial centers. The foreigner feels confidence in the school because his children attend it and he knows it is a democratic institution, without restrictions as to race or creed, and above all, is free from patronage. He is not timid about entering the building. Indeed, he is at ease, feeling that it is his right to enter the place where his boys and girls are receiving their training. Then also, in the school building there are other facilities for Americanization than can be afforded merely by the night classes for the study of the language. The school library and the opportunities for social gatherings are large factors, and through them he learns something of the American modes of thought and action. The foreigner should be encouraged always to attend the night schools. The school building, if carefully planned, will be attractive and inviting to him and he will feel pleasure and pride in his relation to it.

But above all, we should encourage and help the foreign-born laborer to feel that America earnestly wishes him to take advantage of the opportunities afforded him. In this way only can we hope to gain the best results.

Housing.

Owing to the increased labor forces and the very great scarcity of dwellings, the subsidiary companies have built a large number of houses to accommodate their employes. Much thought and study has been given to the designs and plans of these houses, with a view of giving the employe a home with modern comforts and at a moderate rental. Many houses are sold to employes with small initial payments and on easy monthly installments extending over a period of years.

In the populous centers, such as Pittsburgh and Chicago, where many corporation mills are located, the employes are merely a small portion of the city's population and as a rule are provided for in the ordinary way in which a city's people are housed without the intervention of their employers. Where great plants have been built at some distance from any city, as in the cases of Gary and Duluth, and in many isolated mining locations, the corporation has been obliged to provide for such large numbers of its employes that it has built industrial villages adjoining the properties.

In the planning of towns or large dwelling communities the following objects have been kept in mind:

1. Comfortable housing of employes.
2. Healthful surroundings.
3. Education and religious opportunities.
4. Recreation facilities.
5. Civics—to give employes the benefits and opportunities of a small city.

To attain these objects, very careful consideration is given to the location of the town site, so as to affect the most desirable surroundings; the planning of the town with proper streets and alleyways; the design, location and construction of the houses and civic buildings; sanitary provisions to insure healthful living conditions. The houses are well constructed, with due consideration to climatical conditions, are spaced sufficiently far apart to afford the occupants plenty of fresh air and a small garden and yard, and are of different design varying in size from 3 to 10 rooms to meet the requirements of different size families. The majority of the houses recently constructed are complete in every detail including bath rooms, laundry tubs, complete plumbing facilities, furnaces, electric lights, and other conveniences embodied in the modern home for the comfort of the occupants. In order that the unmarried or single men may be provided with suitable living quarters, many boarding houses with all modern conveniences have been constructed, in which the employe may secure accommodations at a reasonable cost. The dwelling houses are all leased to employes at low rental rates and it is the object of the corporation to provide suitable housing facilities for its employes and not with the intention of making a large monetary return on the investment.

Recognizing the fact that religious, educational and recreational facilities play a most important part in the life and social welfare of a community, many churches, schools, community houses, playgrounds and other entertainment buildings have been constructed, which the corporation maintains or materially assists in their maintenance.

While the subsidiary companies have, for a number of years, constructed houses and sold them to their employes on easy payment terms, a "Home Owning Plan" has recently been developed by the corporation as a guide for the subsidiary companies in establishing home owning plans for their employes. These regulations cover the sale of houses owned by the company to employes; the purchase of houses from private owners for re-sale to employes and the building of houses for employes either by the company or by a contractor approved by the company.

The home owning plan is divided into three possible methods of application, which are contingent on the financial ability of the purchaser and the fact that the house is already built or is one to be built. The general method of carrying out the plan is as follows:

a. Installment payment plan for an existing dwelling—This plan applies only to an existing dwelling owned by the company, or bought by the company from a private owner for an employe. The dwelling will be sold to employe under a contract providing for an initial payment of not less than 10 per cent of the purchase price; the balance of the purchase price to be paid in monthly installments extending over a period not exceeding 10 to 15 years, with interest on deferred payments at the rate of 5 per cent per annum. The purchaser may anticipate payments at any time and is offered special inducements for early completion of contract. The title to the property remains in the company until the completion of the contract. If, at any time, he desires to withdraw from the contract he is permitted to do so and receive back all money he has paid on principal and interest thereon, plus 5 per cent interest thereon less a rental which is based on 8 per cent per annum of the purchase price for the period of possession.

b. Installment Payment Plan for Building a Dwelling—Under this plan the company will build a dwelling for employe, title being taken in the name of the company. The company will furnish free plans and specifications and supervise the construction of the house. The dwelling will be sold to the employe under the same plan as outlined under "a."

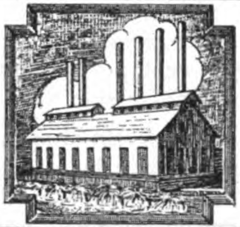
c. Mortgage Plan—This plan will best apply where purchaser is able to make a large initial payment and desires to have the title to the property in his own name. A loan not exceeding 75 per cent of the cost of the property will be made to the employes, secured by a first mortgage bearing interest at 5 per cent per annum. The loan may be repaid in installments. This plan may apply to sales of existing dwellings as well as to houses to be built.

Facilities Provided for Employes.

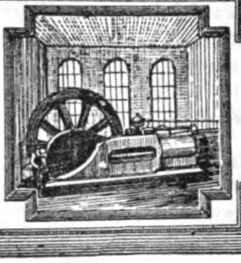
Below is a summary of the facilities constructed or installed for the use of employes for the purposes named:

January 1, 1920.

Number of dwellings and board houses constructed and leased to employes at low rental rates	27,553
Churches	25
Schools	45
Clubs	19
Restaurants and lunch rooms	64
Rest and waiting rooms	210
Playgrounds	131
Swimming pools	11
Athletic fields	96
Tennis courts	107
Band stands	19
Practical housekeeping centers	18
Piped systems for drinking water	369
Sanitary drinking fountains	3,077
Wells and springs protected against pollution	647
Comfort stations (complete units, either bath or dry houses, closets, wash or locker rooms, in separate buildings or within enclosures in the building)	1,495
Water closet bowls	7,307
Urinals	2,551
Washing faucets or basins	17,369
Showers	2,672
Clothes lockers	116,749
Base hospitals	25
Emergency stations	286
Training stations (first-aid and rescue)	62
Company surgeons, physicians and interns	167
Outside surgeons (on a salary)	107
Nurses (including nurses in training)	189
Orderlies and other attendants	115
Visiting nurses	68
Teachers and instructors	222
Sanitary inspectors	30
Safety inspectors (spending entire time on work)	101
Employes who have served on safety committees	25,948
Employes now serving on safety committees	5,500
Employes who have been trained in first-aid and rescue work	16,881
Employes now in training	801



STEAM POWER DEPARTMENT



New Power Plant of National Tube Co.

A Description of the New 10,000 kw Turbo-Generator Unit Recently Installed in Their National Work's Power Plant at McKeesport, Pa.

By **J. W. MARSHALL.**

THE National Tube Company have recently installed a 10,000 kw turbo-generator unit in the power plant of their National works at McKeesport, Pa. This generator, which has been in service since April 7, 1920, replaces two 1,000 kw blast furnace gas engines and four 625 kw vertical cross compound steam engines, which are now maintained for emergency purposes. The new equipment is capable of carrying twice the load that is placed upon it at present and will be able to meet the additional requirements of the plant for some time.

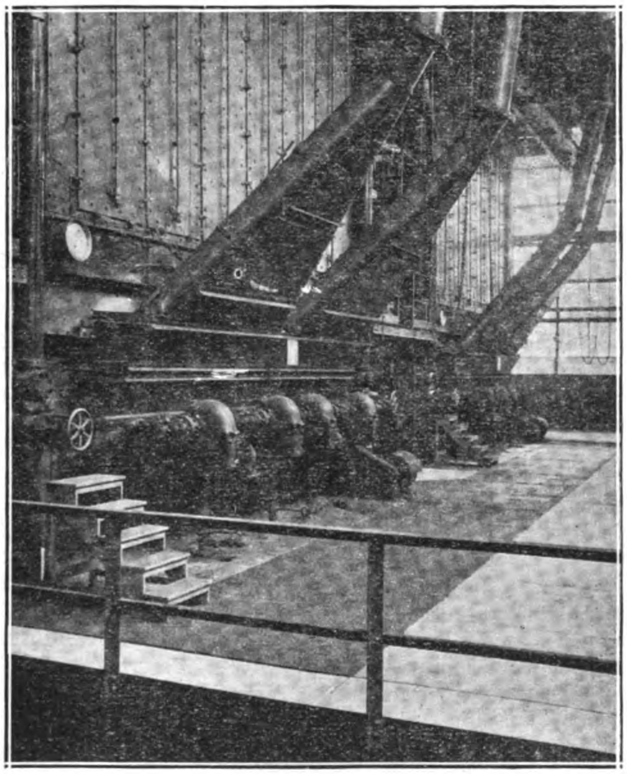


Fig. 1—General stoker arrangement for boilers.

The generator unit is of the three-bearing construction, consisting of a Curtis turbine directly connected to a 3 phase, 25 cycle, 6,600 volt, synchronous, ac generator which has a power factor of 0.8. The Curtis turbine is of the impulse type, that is, the expansion of the steam takes place entirely in stationary nozzles and the impulse of the steam on the revolving buckets gives the driving torque. The rotating part of a Curtis turbine consists of simply a steel shaft and the wheels to which the buckets are attached, while the stationary parts consist of a cast iron casing which encloses the wheels and bearings for supporting the shaft. This generator is air-cooled by the use of air that has first been washed by an apparatus furnished by the American Spray Company and modified by the company's own engineer. This washer will clean 40,000 cubic feet of air per minute, which is forced through all parts of the generator by fans located on the generator shaft. The air is then discharged through a large central duct. The clean, warm air heated in this generator is both humidified and tempered. It is to be used to heat the buildings in the winter months, a complete change of air being circulated every 30 minutes.

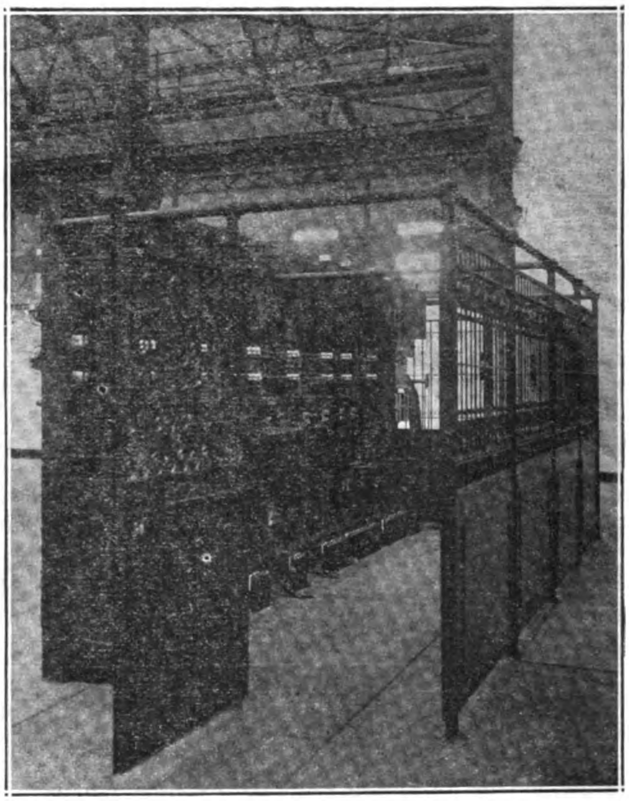


Fig. 2—Back view of switchboard.

In addition to the 10,000 kw set, the company operates a 3,000 kw unit of the same voltage, in another part of the plant. These two sets with a total output of 13,000 kw are connected in parallel and the current is distributed through the plant by the use of motor generator units of 1,000 kw and 1,500 kw capacity that connect the current into 250 volts dc. Two of these generator sets are located in the main power plant, while the others are located in sub-stations which are so arranged that a fairly uniform voltage is maintained in all parts of the plant. The 1,000 kw units are of the two bearing type and 1,500 kw of the three bearing type.

The Curtiss turbine uses steam at a pressure of 250 pounds per square inch that is superheated 150 degrees F., and conveyed from the boilers in a 12 inch steam pipe. It operates at a speed of 1,500 rpm, which is maintained practically constant through the use of a governor, operating on the centrifugal principle. This governor regulates the series of inlet valves located on the top of the turbine. The turbine is designed to use steam at a pressure of 200 pounds per square inch in the initial stage and at constantly decreasing increments through the various stages. In case the speed of the turbine should increase beyond that permitted, the steam would be automatically cut off in the line by means of an automatic trip valve provided for this purpose, and in case the vacuum should cease to function, another valve would automatically come into action and cause the steam to exhaust into the atmosphere, instead of into the condenser.

A 230 volt ac generator, direct-connected to the turbine, furnishes the exciting current for the rotor. A connection is also made with the Duquesne Works of the Carnegie Steel Company by means of which an interchange of power may be made in cases of emergencies.

The three bearings of the set are water-cooled, the circulating water which acts under a pressure of 30 pounds per square inch, as shown by the gauge on the turbine, being discharged into the sewer. A thermometer is kept in the proper place to measure the temperature of outgoing water which is not allowed to increase over 10 degrees above its entering temperature. Oil is supplied to the bearings from a Bowser oil filter located in a room underneath the turbine and is forced through the bearings under a pressure of about 18 pounds per square inch by means of a gear pump that is driven from the main turbine shaft. This turbo generator set has been set on a substantial foundation which is independent of the floor of the building. This is done in order that the vibrations caused by the other machinery in the plant would not be transmitted to it. A layer of felt

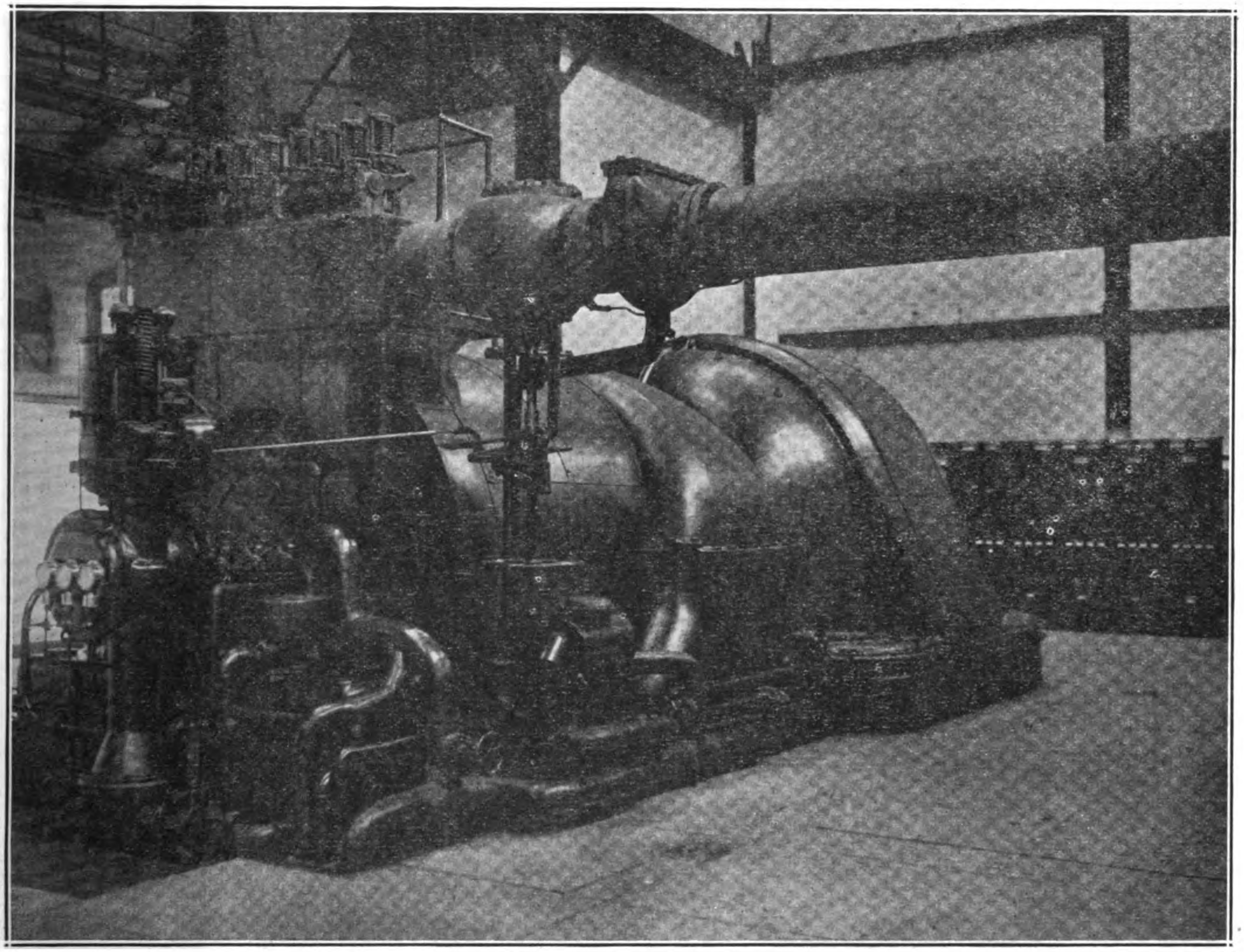


Fig. 3—View showing new 10,000 kw turbo-generator.

¼ inch thick has been placed between the floor system and the turbine foundation.

A gauge board is located conveniently to the set on which is found a standard Holman and Maurer mercury column vacuum gauge, by means of which the exact vacuum is obtained; a Bristol recording vacuum gauge, which is used to show the variations in the vacuum maintained over a 24-hour period; a Taylor standard barometer; a steam gauge connected to the initial stage of the turbine, and a gauge that gives the steam pressure at the throttle.

The control apparatus is so arranged that the sets at the substations may be controlled either by switches located in the substations or by the use of remote-controlled switches located in the main power plant. These sets are all encircled with safety guard railings. All the switching apparatus of the 6,600 volt set is enclosed in a steel cage which is provided with asbestos doors. These doors are kept locked at all times, and only authorized repairmen can get into these cages.

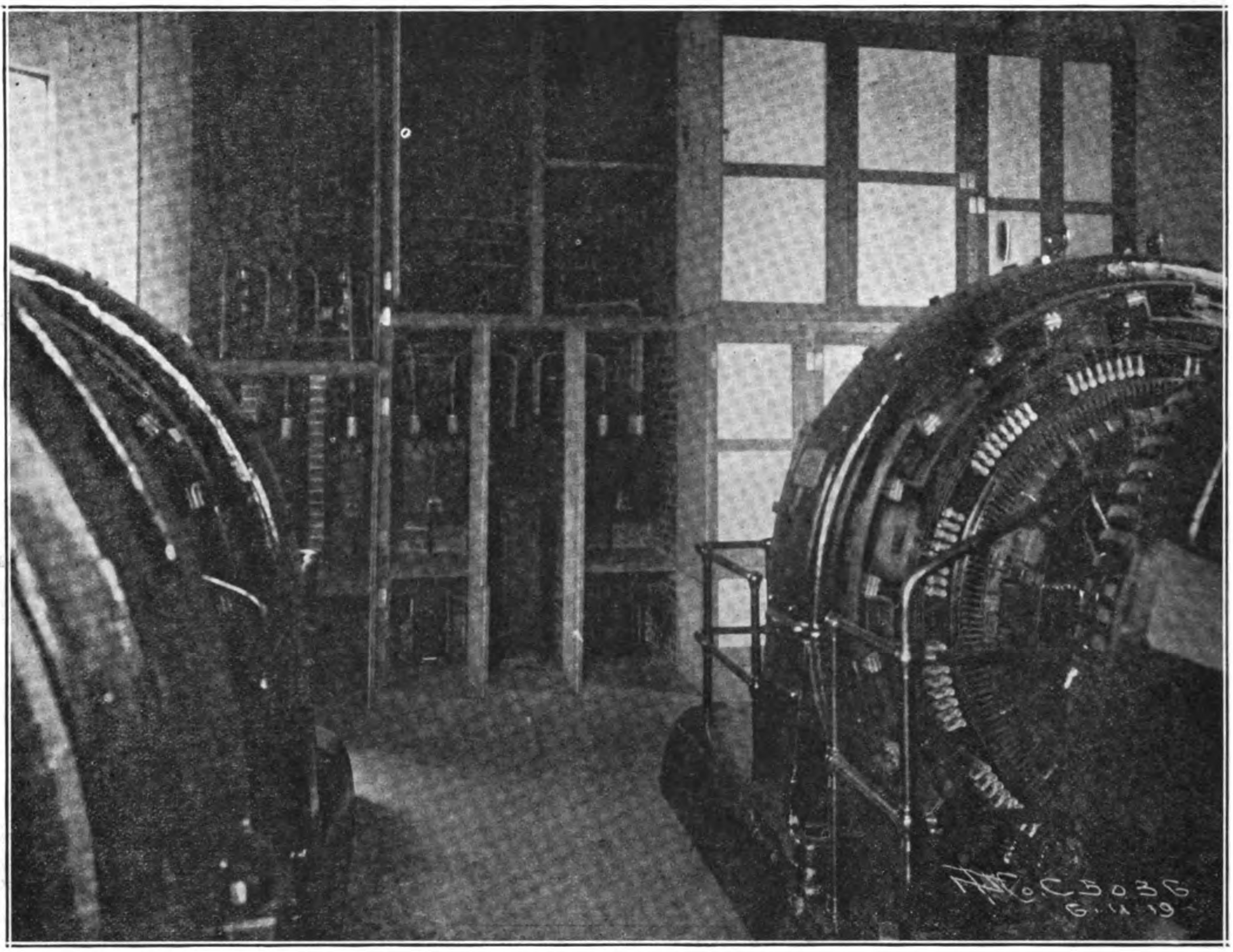


Fig. 4—View showing motor generator sets and switch mountings.

From the turbine the steam passes into a low-level jet condenser made by the C. H. Wheeler Company that has a condenser capacity of 130,000 pounds of steam per hour, and, with condensing water at a temperature of 70 degrees F., produces a 28 inch vacuum. The circulating water mixes with the steam and condenses it, the resulting water being pumped into the river adjacent to the plant. This condenser is equipped with four rado jets for the removal of air, the air and steam present passing from them to the feed-water heater in the boiler room.

Boiler Room.

Steam is furnished to the plant by two 1,500 hp cross-drum Babcock & Wilcox boilers that are located in a well lighted room and fired by Westinghouse stokers. These boilers are equipped with all the latest labor-saving devices. All the coal for the boilers is handled mechanically from the time that it reaches the plant in barges until it is in the boilers. A grab bucket hoist, made by the Brown Hoisting Machinery Company, located on the river front, elevates the coal from the barge to the overhead bin at the rate of about 200 tons per hour. From this bin the coal is hauled by an electric locomotive in drop bottom cars to a 200-ton bin located directly over the boilers. From this bin it is fed automatically through the different chutes to the stokers and thence to the boilers. All the ashes are mechanically removed, being so arranged that the ashes from the boilers drop directly into small cars located below. These cars are then hauled by battery locomotives to skip cars and elevated to the storage bin overhead. A railroad car is then placed under this bin and the ashes are removed to a nearby dump.

In the room above the boiler room are located two forced-draft fans made by the Green Fuel Economizer Company, that operate under a 3 inch pressure and have a capacity of 65,000 cubic feet of air per minute. These fans are direct-connected to Terry steam turbines of 30 hp each. They are used to obtain an increased air pressure under the grates. Two induced-draft fans are also found in this room. These fans are connected to the stack and induce a draft in them. They have a capacity of 70,000 cubic feet of air per minute and are driven by 30 hp Terry turbines to which they are connected by Poole reduction gears.

Next to the boiler a 10,000 bhp Webster feed-water heater is located which utilizes the exhaust steam from the fan turbines and vacuum pump.

Near the boilers is a gauge board on which are located a complete set of gauges for each boiler together with a balanced-draft stoker-control apparatus made by the Balanced Draft Engineering Company. The function of this apparatus is to so regulate the speed of the induced-draft and forced-draft fans that a perfectly balanced draft in the firebox is maintained at all times. Three water gauges for each boiler are located on this board. One of these gauges shows the pressure over the furnace, one shows the pressure under the fire, and the other shows the pressure in the last pass of the furnace just before the gases reach the stack. Four Bristol recording instruments for each boiler are also found here. One of these instruments records the temperature of the waste gas, one the temperature of the steam, one the temperature of the feed water, and one the steam pressure during a 24-hour period. Here, also, are found three Republic steam meters for each boiler. Two of these meters are connected to each of the two branches of each boiler and shows the rate of flow of the steam. The other meter records the total flow of steam over a given period.

The entire plant is in charge of W. T. Snyder, electrical superintendent. Mr. Snyder also had a very active part in its construction. In his office are charts showing the daily kw output of the plant calibrated in hours per day. These charts show the output of the 10,000 kw turbo-generator, the 3,000 kw turbo-generator, the various motor generator sets, and the ac tie line that connects the two turbo-generators.

Smokeless Combustion of Coal in Boilers

Showing How Smokeless Combustion Can Influence Fuel Economy if the Boilers Are Correctly Designed and Properly Operated—Installations Described Where Boiler Plants Have Been Improved.

By **F. J. DENK,**

IT IS a widespread opinion among boiler operators, that a smokeless chimney indicates an efficiently working boiler furnace. Nothing could be farther from the truth. The smokeless condition may be due to some kind of "smoke consumers" or similar appliances, which mostly are a burden to the boiler rather than a help. It is true, the heat losses, caused by the smoke proper, are comparatively small, as the quantity of carbon in dense smoke amounts to only about 1 per cent of the carbon in the coal. But smoke is an indicator of incomplete combustion and the losses due to this condition are high and may go up as high as 15 per cent of the total heat.

The accompanying Fig. 1 shows the relation between the percentages of smoke intensity, the average percentage of heat unaccounted for, the average per cent of CO in the flue gases and the average temperature in the combination chamber, dense black smoke being called 100 per cent. The data, from which the curves have been plotted, have been obtained at the St. Louis testing plant of the Bureau of Mines. The curves show that the smoke density increases with increasing CO and increasing temperature, followed by an increase in the per cent of unaccounted for heat losses.

One point is brought out by the curves, which is not generally known. This is, that the smoke density increases with extremely high temperatures, which condition is accompanied by heat losses through the stack. This is due to the fact that high temperatures indicate an approach to the quantity of air theoretically required for combustion, followed by an incomplete mixture of the air with the gases of combustion.

The production of smoke is due to the following conditions:

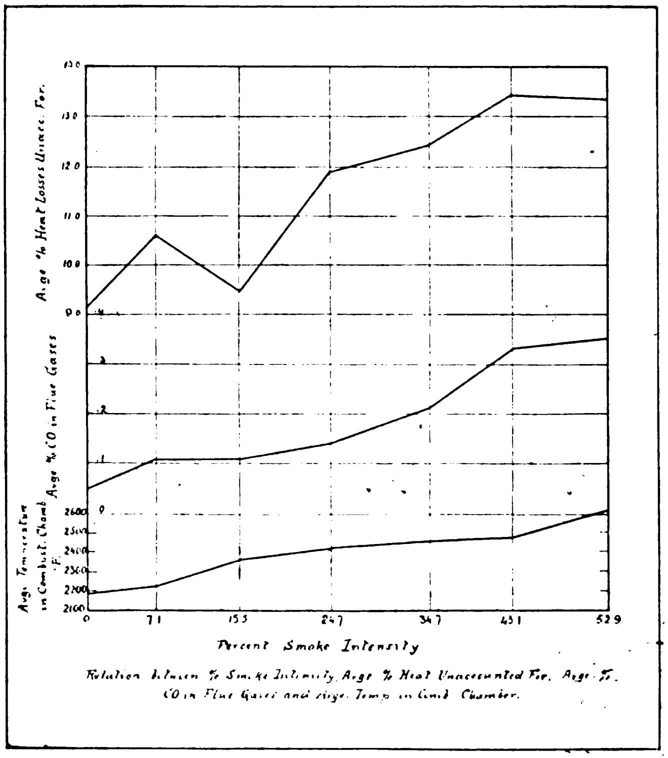
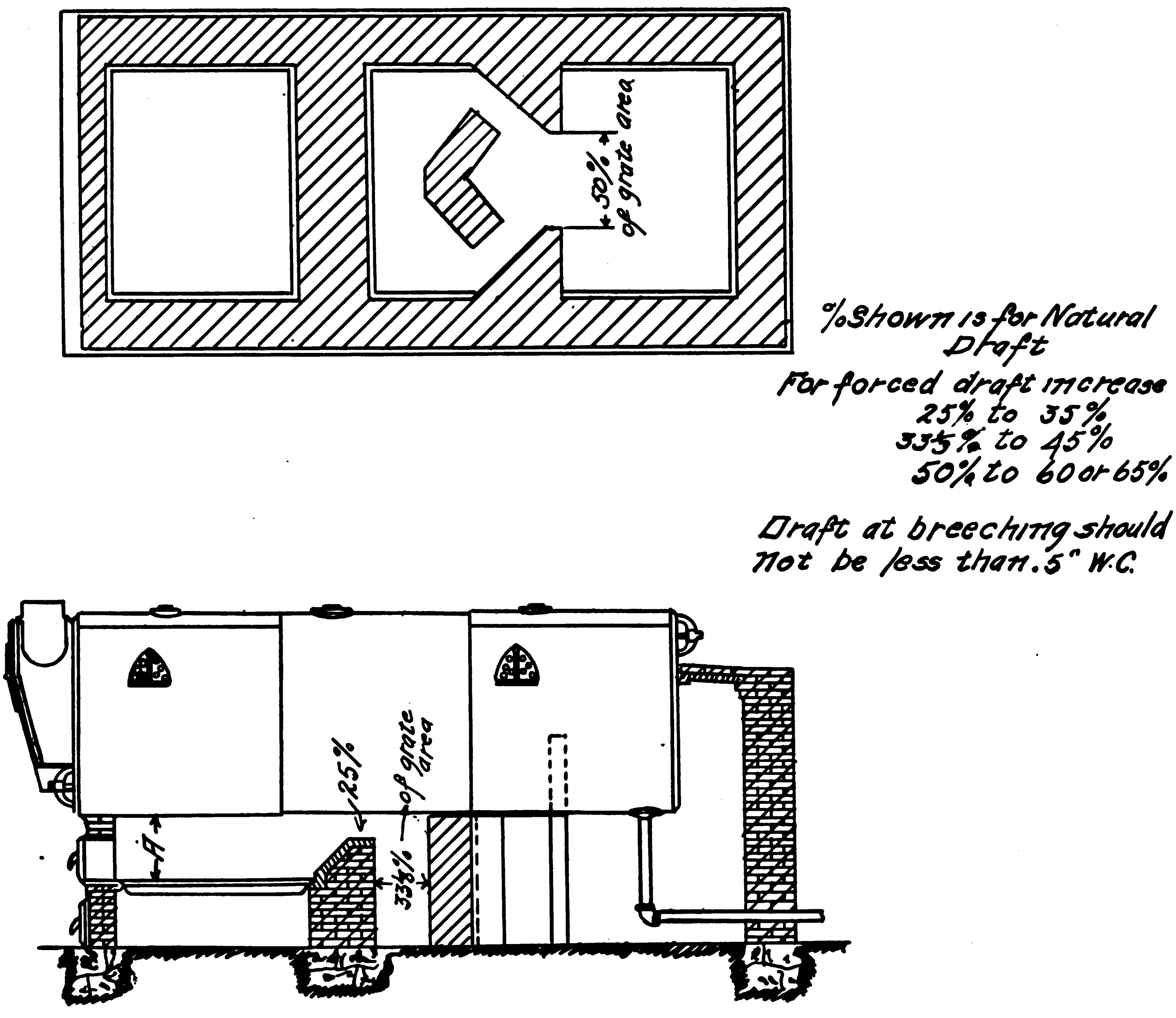


Fig. 1.

1. Deficiency of air.
2. Incomplete mixture of gases and air.
3. Low temperature of combustion.
4. Small combustion chamber.
5. The human element.

Deficiency of air or incomplete mixture of gases and air can be discovered by means of a gas analysis. It is well known, that for complete combustion of one pound of coal 12 pounds of air are theoretically required. The actually necessary amount is about 17 pounds, corresponding to 40 per cent excess air (see Blast Furnace and Steel Plant, June 1920, p 343 ff). Any quantity less than this will, under otherwise equal conditions, produce smoke. Incomplete mixture of gases and air will have the same effect. If gases and air do not mix properly, strata will be formed, and while, at one place, sufficient air may be at hand, there may, at some other place, be not enough air for complete combustion, the gases escaping through the stack unburned, being accompanied by the particles of carbon which had no chance to burn, thus again forming smoke.



% Shown is for Natural Draft
For forced draft increase
25% to 35%
33⅓% to 45%
50% to 60 or 65%

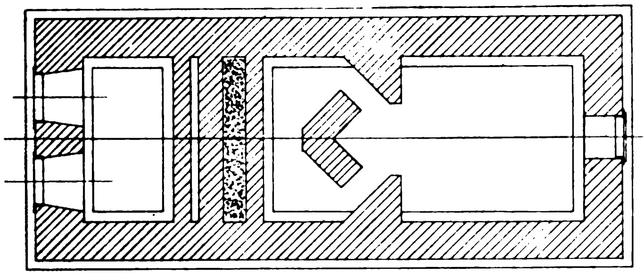
Draft at breeching should not be less than .5" W.C.

Typical Arrangement.
of Setting for Smokeless Combustion for RT Boiler
Hand Fired

Fig. 2.

Low temperature is actually only a result of the two causes mentioned before. If the gases have no chance to burn completely, the right temperature of combustion cannot be attained. Therefore, incomplete combustion, indicated by a comparatively low temperature, is followed by smoke.

One of the main causes of the production of smoke are too small combustion chambers. The old designs called, for instance, for a return tubular boiler, for a height of 22 to 30 inches between the grates and the shell. Until a few years ago, this distance was enough for complete combustion and an elimination of smoke. But, if it was sufficient then, why is it not sufficient now? There are two reasons for this condition. The first is due to the different ways of operating the boilers and the second is due to the kind of coal used at present.



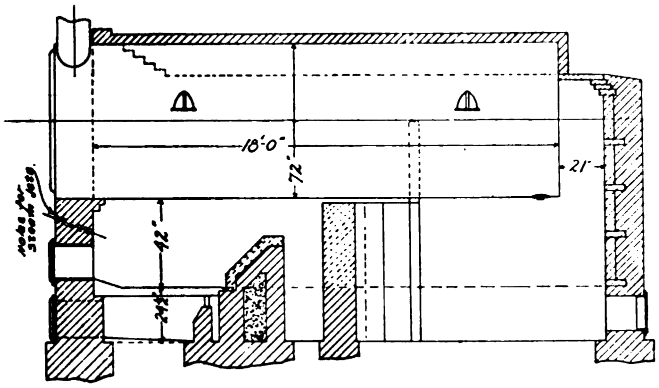


Fig. 3.

Until the time of the war, boilers were mostly run at rated capacities or a little lower. If a boiler was built for, say 150 hp, these 150 hp were strictly adhered to, with some rare exceptions. To force a boiler to carry 25 per cent overload except for short periods, was considered a crime. The writer remembers well the arguments he had with an engineer who had charge of four 150 hp Heine boilers. The factory requirements were about 500 hp and to obtain this the four boilers were running each with 125 hp. The writer tried to convince the engineer, that he could get the same output with three boilers, if he would overload each one to about 12 per cent, but the engineer would not do it, saying, that the boilers were built for 150 hp and not for 170 hp.

At the present time overload of 100 per cent are the rule and many a new boiler plant has been designed with this end in view. Of course, if old boilers are supposed to be run with high overload, the combustion chambers are too small and are bound to produce smoke.

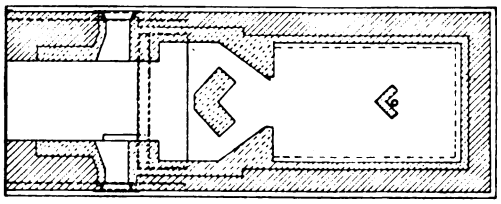
If the combustion chambers are designed right, bituminous coal, high in volatile matter, can be burned without producing smoke, not only where loads are uniformly distributed, but also where loads are carried, which vary between wide limits. The requirements are careful and intelligent supervision, efficient labor and proper equipment.

The second reason for the old distance between grates and shell or tubes being insufficient for present working conditions is due to the kind of coal mined and shipped today. As a rule we get coal of a lower grade than we could buy a few years ago. Formerly and until the summer of 1917 the incentive of competitive marked conditions had maintained a practically uniform quality of the coal by special preparation. But from then on, the demand for coal was so insistent and the needs of the consumers were so pressing, that screening and washing were largely abandoned; throughout the country the complaint was heard, that coal was not being cleaned as in the past, that dirty coal was shipped (U. S. Geological Survey, Coal in 1917, part A, page 943). This change in quality of the coal requires a change in the furnace design.

If new boilers have to be installed, the modern requirements can easily be taken care of. But this is different with old boilers which must be changed to suit the new conditions. The main point to be kept in view is, that the intended changes have to be always made in such a way that the principles of combustion are adhered to. No boiler will work efficiently and without producing smoke unless this rule is strictly followed.

One of the first rules to be observed is that the coal is fed on the grate in small quantities and at short intervals. This, of course, is best attainable with automatic stokers, which supply the coal continuously and uniformly. The closer hand feeding approaches this condition, the less smoke will be produced.

Another rule which has to be kept in mind is to give an air supply which is about 40 per cent in excess of the amount theoretically required (see above).



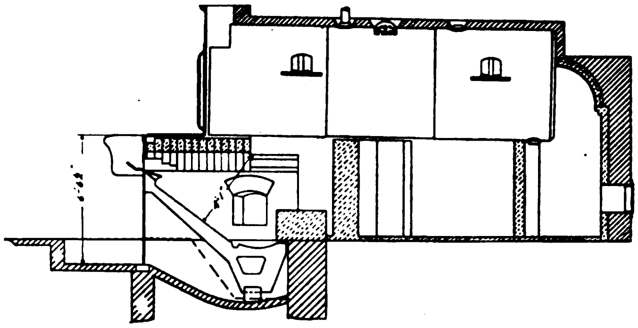


Fig. 4.

Finally, the combustion chamber must be designed in such a way, that it allows a thorough mixture of the gases and the air. This is the main point to be observed, as improper mixture will cause incomplete combustion, no matter how well the other rules are taken care of. We can feed the coal as uniformly as possible, we can admit the air in the required quantities, if we do not give the gases, driven off from the coal, and the air, admitted into the combustion chamber, a chance to mix properly, we cannot expect the boiler furnace to work right and to produce the expected results.

In the following a few installations will be described which had been effected by improving old boiler plants.

Fig. 2 shows the general data for setting of a return tubular boiler, to produce smokeless combustion, as recommended by the Bureau of Smoke Regulation of the City of Pittsburgh. The distance between grates and shell is marked 4 feet. This is the minimum permissible, which might only be made less when conditions demand it. Under no circumstances should this distance be less than 3 feet 6 inches; it rather should be increased where possible. The writer knows of places where this distance is 6 feet. The free area over the bridgewall is given as 25 per cent of the grate area and the free area between the bridgewall and the deflecting wedge as 33 1/3 per cent of the grate area. The opening between the two wings in back of the deflecting wedge is supposed to be 50 per cent of the grate area. All these figures are for natural draft; they should be increased to 35 per cent over the bridgewall, 45 per cent between bridgewall and wedge, and 60 to 65 per cent between wings. The draft at the breeching should not be less than 0.5 inches wc.

These figures vary, of course, with conditions where old boilers have to be changed. The writer had occasion to rebuild five hand-fired boilers, having a total capacity of 470 hp (see Fig. 3). Due to the limited space overhead, the distance between the grates and the shell had to be made 42 inches which still was better than the original 27 inches. The five boilers were connected into one stack, which was smoking continuously before the change was made. After remodeling the boilers, the smoke nuisance was practically eliminated.

Fig. 4 illustrates the arrangement for a return tubular boiler with a Roney stoker. This installation has also given good results as well as the arrangement, shown in Fig. 5, illustrating a B. & W. boiler with a Roney stoker. The boiler, shown in Fig. 4 was new, while Fig. 5 represents a change from an old setting. Here, too, was not enough room overhead to raise the boiler to the required height, but the installation proved successful and smoke was eliminated.

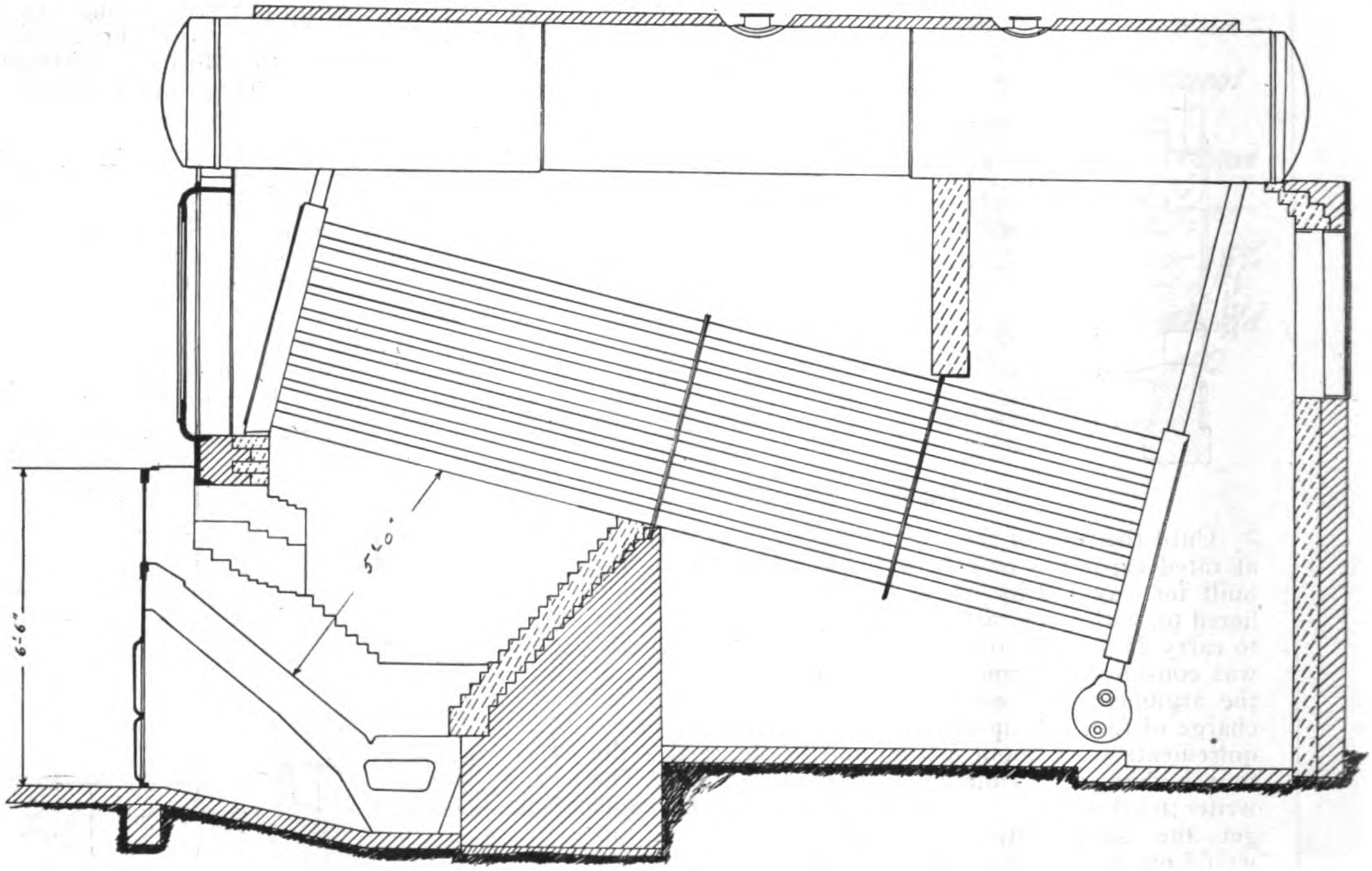


Fig. 5.

On the front wall of the boiler, Fig. 3, holes are shown for steam jets. These steam jets are one of the many devices used with hand-fired boilers to prevent the formation of smoke by helping to obtain a good mixture of the gases with the incoming air. The jets are, in most cases, not automatic and they are, for this reason, in many plants, allowed to run longer than they should do. The main object of the steam jets is to mix the cold air entering the furnace, whenever the fire doors are open, which the gases, generated on the grate. This service is performed as soon as the doors are closed. The steam jet should, therefore, be shut off at that time, as it will waste more energy of the coal when allowed to run longer, than it will save. In order to prevent this waste, automatic opening and closing devices have been designed, one of which is shown in Figs. 6 and 7.

Sometimes the claim is made that the use of a steam jet will increase the thermal value of the fuel, as steam would be dissociated and aid the combustion by adding oxygen to the air. The oxygen would form a valuable addition to the fuel gases. This claim, however, is erroneous, because, in the first place, it takes the same amount of heat to dissociate a pound of steam into hydrogen and oxygen, as is given off when a pound of steam is formed by burning hydrogen with oxygen. In the second place, it is very difficult to burn hydrogen in the average boiler furnace. The result is, that part of the hydrogen goes through the stack unburned, thus increasing the stack losses. Another item, not to be overlooked when using steam jets, is, that the steam entering through the jets has to be heated to furnace temperature. The heat necessary to do this can only be taken from the coal, which is thus robbed of part of its energy.

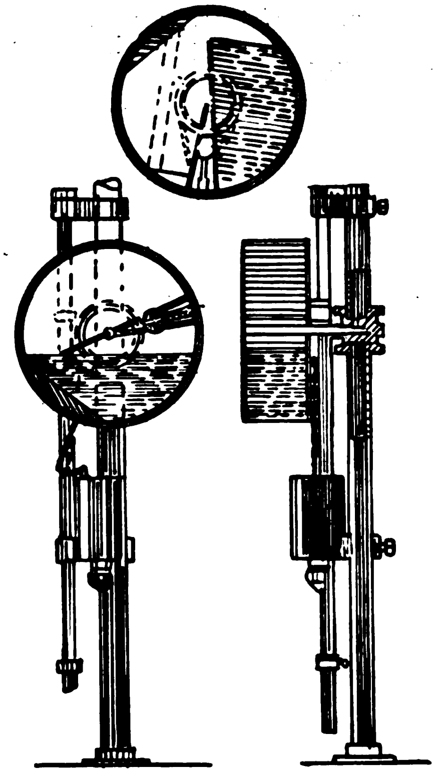


Fig. 6.

All this shows that the application of steam jets is permissible only when greatest care and precaution is used. And this leads to the last point of our discussion, i. e.: the influence of the human element on the efficient running of the boilers.

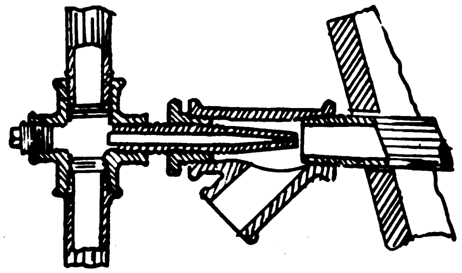


Fig. 7.

No matter how well a boiler furnace is designed, if the men in charge of the boilers are careless or inexperienced, losses will result. The writer refers in this respect to Figs. 1 and 2 on page 343 of the June issue of this magazine, which plainly shows the influence of watching the operation of the boilers. As stated above, careful supervision and efficient labor have to work hand in hand, and if they are supplemented by a correct design, there is no reason whatever why the formation of smoke could not be prevented to the satisfaction of all concerned.

Use of Preheated Air for Combustion

Explaining the Various Uses and Advantages of Preheated Air in Blast Furnaces, Melting Furnaces and Open Hearths and Its Use in the Combustion of Fuel Under Boilers.

By JOHN VAN BRUNT,

Combustion Engineering Company.

THE use of preheated air for combustion of coal, coke, oil and gas is and has been quite general in the steel industry in blast furnaces, melting furnaces, air furnaces and open hearth furnaces, and in some reheating furnaces, but in spite of the many known advantages little, if anything has been done here to apply preheated air in the combustion of fuel under boilers.

In marine boilers its use has been known for some years and many installations on shipboard have been entirely practicable and successful. The best known consists of a tubular air heater located in the breeching of Scotch marine boilers, a fan being used to force air through the tubular heater and ducts to the ash pit, and an induced draft fan to draw the furnace gases through the heater. This system is frequently used in connection with Howden's forced draft system by which the heated air is delivered both above and below the grate.

Another system is the Ellis and Eaves system which is also used in connection with marine boilers. This system is very similar to the Howden system, differing principally in the details of application.

The gain due to the use of an air heater is twofold. First: It returns to the furnace a definite amount of heat which can be calculated as readily as that returned to the boiler by heating feed water, and second, the introduction of heated air has a definite value in facilitating combustion. Every fuel, or combustible constituent thereof, has a certain temperature at which ignition takes place, and the hotter the air introduced into the fire, the more prompt and vigorous is the chemical reaction of combustion. It is probable that in a given fuel bed of uniform resistance less weight of heated air will be required than would be the case were the air not heated. The volume of heated air will be greater, of course, in proportion to the absolute temperatures. Thus if air be heated from 70 degrees F. to 250 degrees F., the volume of the heated air will be approximately 33 per cent greater, and in order to pass the same weight through the fire the velocity will have to be increased a like amount.

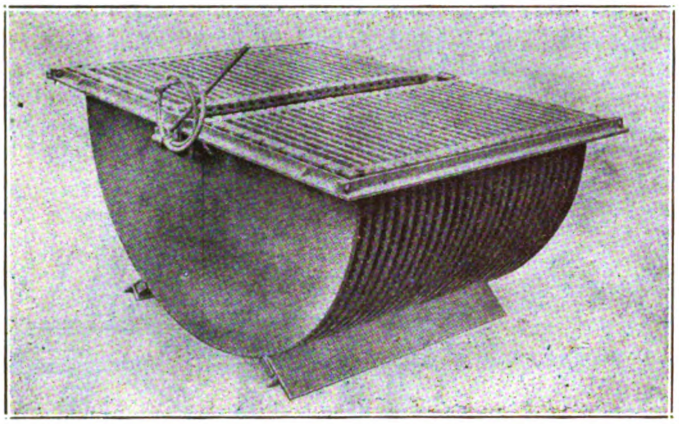


Fig. 1—View of complete heater.

Another direct gain is in fire or furnace temperature which results in a gain in boiler efficiency entirely apart from furnace efficiency. For example, assume that a furnace and boiler uses cold air 50 per cent in excess of the theoretical amount required, and that the gas analysis is 12 per cent CO_2, the flue gas temperature is 500 degrees, and the rate of combustion is 30 pounds per square foot of grate. Suppose now that preheated air were used in the same weight so that the CO_2 and flue gas temperatures were the same. If the same weight of coal were used the evaporation would be greater because of the actual heat units added by the heated air. Further, the furnace gases would be hotter than if cold air were used, and the boiler efficiency would be increased. In this respect a boiler is like a steam turbine in that the higher the temperature of steam entering, the greater the possible efficiency.

To the writer's knowledge there are no boiler plants of any size in this country using preheated air for combustion except possibly a few experimental installations. In England considerable work along this line has been done by the Underfeed Stoker Company, Ltd., to whom the writer is indebted for much of the following data.

A complete description of an air heater installation in the plant of the Northampton Electric Light & Power Co., England, is given in the March 1, 1918, issue of "Engineering," of which the following is a brief extract:

Boilers, 2 horizontal water tube, 5,346 square feet each.

Normal duty, 21,000 pounds steam per hour from feed water, 100 degrees to steam at 200 pounds pressure and 260 degrees superheat.

Maximum duty, 26,200 pounds steam per hour from feed water, 100 degrees to steam at 200 pounds pressure and 260 degrees superheat.

Each boiler equipped with formed draft traveling grate stoker of 72 square feet grate surface.

Each boiler fitted with plate type air heater of 2,668 square feet, the ratio of heating surface to coal burned normal duty being .8.

Coal—fine slack of 10,000 Btu. per pound as fired.

Temperatures: Gases leaving heater, 400 degrees. Air leaving heater and entering stokers, 230 degrees.

Guaranteed overall efficiency, three-quarter to normal load, 80 per cent; one and one-quarter load, 78 per cent.

Assuming that the flue gases contain 12 per cent CO_2, the per cent of heat returned by heated air will be approximately 6½ per cent.

From official trials in 1912 of Clarke Chapman boilers fitted with plate heaters the following table is compiled:

Duration of test	6	4	6	4
Size of boiler sq. ft. H. S.	4100	4100	4100	4100
Sq. ft. of grate unfeed stoker	77	77	77	77
Steam pressure gauge	156	160	160.2	160.2
Degrees superheat	107	117.6	105.7	132.
Temperature feed water	87.8	88.2	88.25	87.75
Factor of evaporation	1.24	1.248	1.24	1.256
Water fed to boiler	111183	99050	111335	95814
Total coal	14484	13100	14400	12700
Calorific value mean of 3 tests	10,845	11,009	10,991	11,130
Rise of temperature through heater	146.	153.5	171.6	184.2
Air pressure at stoker wind box	1.38	2.45	1.45	2.17
Flue gases before entering heater	525	591	584	647
CO_2	12.28	13.87	11.2	12.23
Efficiency overall	84.8	82.8	84.3	82.2
Approximate per cent of heat returned by air heater	4.6	4.2	5.9	5.5
Percent of rating	162	218.5	162	202.7

The last line is added to indicate the rate of evaporation during the tests as in Europe and Great Britain it is not customary to rate boilers in horsepower, not in square feet of heating surface or pounds of water evaporated.

Fig. 1 shows assembled plate heater ready to place in flue. Fig. 2 shows side view of assembled heater with steam connection and sweep for cleaning the gas passage. Fig. 3 shows a single air element. Fig. 4 shows heater partly assembled in flue. The gas passes straight through between the air elements and the air passes through the elements entering and leaving at right angles to the flow of gas.

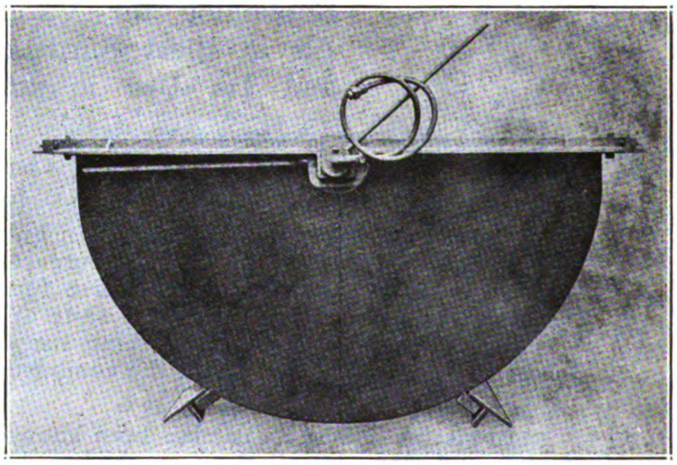


Fig. 2—View from side showing cleaning apparatus.

Each element consists of two No. 10 or 12 gauge black plates riveted to bent bars which form stiffened and curved paths through the element. Careful workmanship is essential to insure tightness against air or gas leaks. The air space between plates is from 1 inch to 1½ inch and the elements are spaced 1¼

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to 1½ inch apart, depending on the length of the element. The space between elements constitutes the gas passage.

Assume a 500 hp boiler to operate at 200 per cent of rating continuously and 250 per cent for short periods, and a ratio of 0.8 square feet of heated surface per pound of coal burned at 200 per cent rating. Assume 4 pounds coal per boiler hp or 4,000 per hour. The heated surface will therefore be 3,200 square feet. Take an element containing 96 square feet of No. 12 plate. There will be required 328 of these elements, each about 10 feet long and 5 feet long, spaced about 3 inches center to center. Such element will weigh including supports, but not including air connections or flue, about 550 pounds, making a total weight of about 21,000 pounds. If located in an overhead or steel flue, provision must be made to support this weight, so we can assume a total weight of 26,000 to 27,000 pounds.

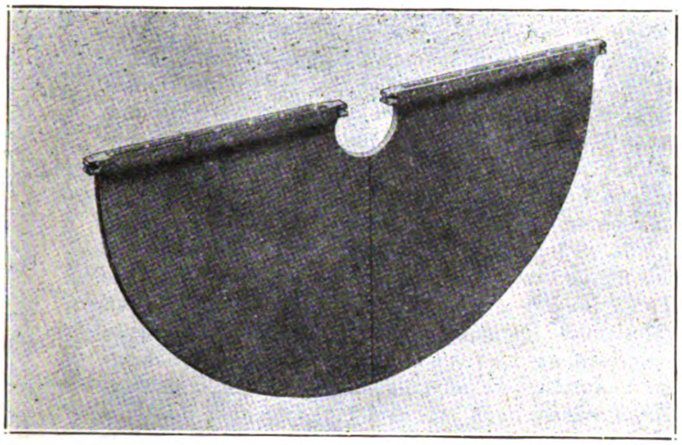


Fig. 3—View of single leaf or unit.

The air heater alone, complete, would cost about $5,000 at present prices of labor and material. Assuming $2,000 additional for auxiliary work, supports, enlarged flue, installation, etc., we have $7,000 as cost of heater installed. Assume a total fixed charge, including repair of 15 per cent of $1,050 per year, to which we must add a certain proportion of the power cost and fixed charges of the forced draft fan equipment and induced draft equipment or chimney.

The introduction of an air heater causes an increased draft loss of the flue gases and a greater pressure loss in the forced draft. The fixed charges and operating cost due to this increase should be added to the fixed charges of $1,050 above named to obtain the total operating cost of the heater. Assuming this to be $500 per year, we have a total cost of $1,550 per year.

With coal at $6.00 per ton, 7,200 boiler hours per year at 750 hp average rating, and 4 pounds of coal per boiler hp, a saving of 6 per cent due to air heater will amount to $3,888 per year, or $2,338 net over all charges.

In general in any plant where there is plenty of steam for heating feed water, and where coal is high in price, an air heater will effect a sufficient saving to warrant its installation even at present costs.

Each case, however, presents its own problem and a careful analysis made of all conditions before reaching a conclusion, as frequently the cost of changing flues to accommodate a heater would be so great as to preclude any possibility of an adequate return on the investment.

The choice between an economizer and an air heater will usually depend on the existing temperature of feed water. For example: If the feed water is at 200 degrees the possible rise in temperature through an economizer is with a moderate extent of heating surface much less than the possible rise in air temperature through an air heater where the initial temperature of air is between 50 and 80 degrees. In cold weather the gain is even more apparent.

The conditions governing the selection of an air heater are much the same as where economizers are considered, the principal factor being the cost of fuel. The determining factor is: Will it pay? Will the saving in fuel be sufficient to pay the fixed charges, repairs and operating cost, and leave enough net saving to warrant the cost of its installation?

There is no reason why air heaters should not be used with any type of boiler or in any kind of boiler plant whether in public service central stations, factory or steel mill as the character of service or load curve would have little, if any, bearing on their successful use.

Air heaters of this type may, of course, be used to provide air for heating shops or work rooms, for drying raw material or finished product. These, however, constitute another field entirely foreign to the subject of this article.

Another combination, which in many cases will work out very satisfactorily, is the use of a comparatively small economizer together with an air heater of sufficient size to bring the gases down to 300 degrees F. Whether an arrangement of this kind is desirable could, of course, be determined only by the conditions in the plant, that is the amount of steam available for feed water heating together with the fluctuation of such amount of steam.

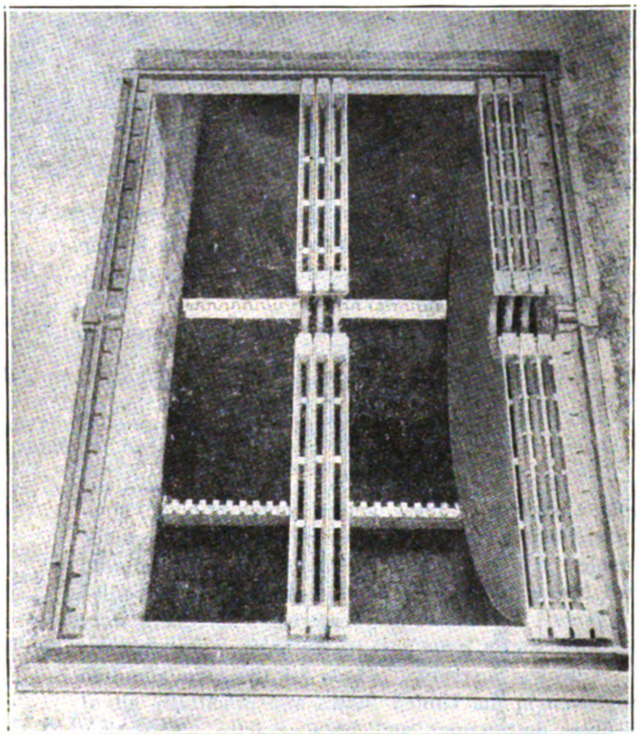


Fig. 4—Air heater in course of erection.

INDUSTRIAL RELATIONS

ADMISSION AND DEPARTURE OF ALIENS.

(From Inter-Racial Council Bulletin G6 24)

The agricultural and industrial demands for unskilled labor, which are so evident throughout the country have in no way been satisfied by the apparent increase in immigration to the United States during the past few months—despite the fact that the total number of persons admitted is now, for the first time since we entered the great war, greater than the total number departed.

During the six months from July 1, 1919, to December 31, 1919, the total number admitted was 162,883 and departed 166,212, a net loss of 3,329. In the same six months of 1913 (the last year of our normal immigration), the total number admitted was 734,869, and departed 153,790, a net gain of 581,079. An analysis of these figures by races (as given in detail on page 2 of this bulletin), indicates that in 1913 there was an increase in 39 of the 40 races listed. In 1919, however, 12 of the races that normally provide the bulk of our unskilled labor supply (marked x), including Serbians, Greeks, Italians and Roumanians, show a total decrease of 86,102, and six other races that also usually furnish large numbers of unskilled immigrant workers (marked a), including Russians, Ruthenians, Bohemians, and Lithuanians, show a total increase of only 2,159. The 18 races that during this period show an increase of 64,443 (most of these not marked), including the English, French, and Scotch, do not generally engage in the basic agricultural or industrial work of the country. The Mexicans (marked b) also show an increase of nearly 18,000, but they were generally admitted under bond (as illiterates) to meet the agricultural needs of border states. It has been stated also that more than half of the total number admitted were women and children coming to join members of their families, while practically all of those who departed were adult male wage earners.

During the first five months of 1920, the preliminary figures for the port of New York (which usually handles about 80 per cent of the total immigration and emigration for the country) show a net increase of 38,288 as follows:

Month	Admitted	Decrease	Increase	Decrease
January	25.051	24,529	522	....
February	22,086	24.379	.....	2,293
March	29,098	18,714	10.384	....
April	36,958	26,169	10,789	....
May	40,048	21,162	18,886	....
	153,241	114,953	40,581	2,293

A comparative analysis of these figures cannot be made, however, as the racial classifications of those admitted and departed are not available. It appears that practically all of those who left the United States during these five months were able-bodied male wage earners. Of those who entered, about half were women and children and a large part of the balance were natives of Italy and returning reservists. Many of the men admitted had previously been in the United States and practically all of them had definite destinations and knew exactly where they wanted to go. Comparatively few new able-bodied aliens are arriving, as a number of the European countries do not yet permit men of military age to leave their borders. Our own wartime passport regulations requiring an American consul's visé before an alien is allowed to board a vessel, the enforcement of the illiteracy test and the fact that many of the large passenger steamers formerly bringing in immigrants are now out of commission, will temporarily retard a return to the pre-war immigration to the United States.

REPORT OF COMMITTEE ON "SAFEGUARDING MACHINERY AT ITS SOURCE."

By H. A. Schultz, U. S. Steel Corporation.

Your committee has been so recently appointed that it has hardly had time to get into action and this report can contain little more than a statement of present conditions and a promise for the future. Some three years ago the National Safety Council appointed a committee using the same title as that of this committee. The first committee working on this subject was very energetic but as it was pioneering it was rather difficult to point to results. Probably the most important feature of the work of the first committee was in paving the way with the Machine Tool Builders Association and with the American Society of Mechanical Engineers. That this pioneer work was in a measure successful and also as a reflection of the trend of things we have but to turn to the advertising pages of such publications as *Machinery*, the *Iron Age* and the *American Machinist* where page after page show machines pictured with hazardous points guarded. It is true that the guarding is not always adequate, and also that the manufacturer sometimes fails to guard all of the hazardous points, but on the other hand think of the advertising pages of 10 or 15 years ago. In those days the gears, power transmission, etc., were devoid of any covering.

Before we get any further let us agree that by safeguarding we mean the guarding of gears and all other hazardous points, and also improvements which will eliminate the hazards at the point of operation. It is perfectly obvious that the best time to safeguard the machine is while it is being designed. Then only can we hope to incorporate the features essential to safety and obtain the kind of a job that is pleasing to the eye and satisfactory to the critical inspection of the engineer inspector and the plant manager. Too often, unfortunately, the guards that are installed after the machine is in its working position in the shop are frail, unsightly and inadequate.

Safety specifications should be based upon practical recognized safety standards and should be drawn up in a form so that they may be included and used as a whole, or in part, for any contract for construction work, or for purchase and installation of machinery and equipment. A set of safety specifications should be attached to, or embodied in general specifications when originally submitted to contractors or manufacturers for bids. In this manner the contractor or manufacturer will be fully advised as to the safety requirements and these features will be included and properly taken care of during the process of construction.

Where the size of job or the character of the equipment involved warrants, it has been found very desirable to go over the safety specifications in detail with the contractor before the work is started and during the process of designing, and then inspect the equipment in the contractor's shop before shipment is made. By so doing, a mutual understanding between the contractor and the purchaser may be reached regarding the safety features, and unnecessary expense incident to additions in the field may be obviated.

The work of this committee will necessarily depend very much on the degree of coöperation it secures from the members of the section and probably the greatest help in addition to suggestions would be secured when purchasing departments demand that the machinery ordered be furnished with all necessary safeguards and that such guards must comply with state laws, insurance companies requirements, and the requirements of the safety department of the purchaser.

FOREIGN RELATIONS

STATUS OF STEEL INDUSTRY IN FRANCE.

(Prepared by the European Division, Bureau of Foreign and Domestic Commerce).

Steel manufacturers and merchants throughout France are all of the same opinion—that the present demand in France for foreign steel products, including plates, sheets, beams, sections, channels, wire rods, tubes, and angles for railway car construction, will continue for at least a year. No homemade plate is available for the independent shipbuilding plants. Such ship plate as is now produced passes directly from the mills to shipyards in which the mills are financially interested. It is said that by September only 25 per cent of the shipbuilding concerns will be operating, due to the shortage of materials.

Demand is assured as long as the present output of coal and coke remains inadequate. Lack of fuel has already reduced the iron and steel production to one-third. Conditions are improving gradually, and even without its new territory France will probably get back to two-thirds its pre-war capacity within a year. Exporting naturally may not be expected before that time.

The shortage of coke is becoming serious. England has curtailed its usual supply and now there is a project on foot to use American coal in coke making.

Although the demand exists, the present rate of exchange has discouraged any large orders for foreign materials. The consumers are simply waiting in hope that the exchange will drop sufficiently to warrant importation. The prices of French steel cannot be reduced materially for some time, owing to the existing wage scales and the present cost of living, both of which are three times the amount before the war. Coal is 6 to 10 times pre-war schedules. For instance, coal mined in France which used to cost 48 francs per ton is now sold at 340 francs, while the English and American coal coming to France at present is selling for 330 and 375 francs, respectively.

Even though the cost of living may come down in the future, it will prove difficult to adjust the labor rates to a lower scale. The men were greatly underpaid before the war. The general run of foundry men received only 5.50 francs for 10 and 11 hours' work. They now receive approximately 15 francs for an eight-hour day, which, considering the present purchasing value of the franc, is little improvement over the former scale.

Consequently France should be a good market for American steel until such time as the French manufacturers are able to secure a cheaper source of coal.

IRON AND STEEL DEVELOPMENT IN BRAZIL.

(Assistant Trade Commissioner R. M. CONNELL, May 18, 1920)

A contract signed recently with the Itabira Iron Ore Company, Ltd., by the Minister of Communications and Public Works in Brazil authorizes that company to construct and exploit, without monopoly, high temperature furnaces, a steel factory and reducing apparatus, as well as two railway lines, which leaving respectively from the mines of Itabra do Matto Dentro, State of Minas Geraes, and from the port of Santa Cruz, State of Espirito Santo, connect with a track of the Victoria to Minas Railway. Moreover, the Government permits the company to erect a dock on the margin of the river Piraque-Assu, in Santa Cruz, with the necessary installations for loading and unloading of minerals. The new contract calls for a minimum production of 150,000 tons yearly, of square bars, round bars, plates, beams, rails, and iron of different sections.

FINANCING EXPORTS FROM UNITED STATES TO JAPAN.

(Trade Commissioner ALFONSO JOHNSON.)

Exports from the United States to Japan are usually financed by credits opened in America in gold dollars by a bank in Japan. These credits are drawn against by the sellers after shipment of the goods, and the amounts of the relative drafts, to which complete shipping documents are attached, are paid over to them by the bank with whom the credit has been arranged. The usance of such drafts is generally 60, 90, or 120 days' sight. On the arrival of the draft and documents in Japan, acceptance is obtained and the said draft and documents remain in the bank's hands until maturity. It sometimes happens that the consignee requires delivery of the goods before the due date of the draft, in which case the bank may at its own risk and discretion deliver same against a trust receipt; this practice is quite common, but such privilege is extended only to consignees of the highest standing.

The drawee settles exchange gold dollars/yen with the bank, and retires the draft any time at his convenience up to the due date. The landing and storage of the goods are looked after by the drawee, as is the insurance, while the goods are in the warehouse. There is no charge for commission by the collecting banker, who looks to the relative exchange operation for his profit.

Exchange quotations are published daily, but often are only nominal.

NEW NAIL FACTORY IN LA PAZ, BOLIVIA.

In August, 1919, the Fabrica Nacional de Clavos (National Nail Factory) began operations in La Paz, Bolivia, with a capitalization of 120,000 bolivianos (1 boliviano = $0.3893). Fifteen sizes of ordinary steel builders' nails and 10 sizes of furniture nails, besides roofing nails, are made, all of which appear to be of very good quality. To date, only about 600 Spanish quintals (60.150 pounds) of nails have been turned out, which is estimated to be the national consumption of nails for two months. In order to secure the continuance of a duty on steel-wire nails (30 centavos per kilo) which was passed by the Bolivian Congress to protect the new industry, the factory must produce 5.000 Spanish quintals of nails per year and must maintain its prices at less than 40 bolivianos per quintal.

Imports of steel nails into Bolivia for the years 1915-1918 were as follows: 116.504 kilos in 1915; 168,236 kilos in 1916; 237,034 kilos in 1917; 138,650 kilos in 1918. During the latter year the United States shipped 55,312 kilos. Of other classes of nails there were imported 86,555 kilos during 1918, the United States supplying 25.396 kilos. Besides the production of nails, the factory has also begun the manufacture of mosaics, paving, and artificial marble.

PRODUCTION TOPICS

HISTORY AND DEVELOPMENT OF TIN PLATE.

The coating of iron plates with tin is supposed to have originated in Bohemia. The process was quite crude, but was zealously guarded. About the same time as the landing of the Mayflower, a Duke of Saxony obtained sufficient information through a false priest to enable him to start the manufacture of tin plate. In 1665 an Englishman visited Saxony and on his return to England attempted to start the industry there, but the crown granted an exclusive monopoly to another man in 1691, and for some unknown reason this man was not successful.

During the next 30 years little or nothing was done, but in 1720 its manufacture commenced in Wales. During this period the process had been developed to a certain extent in Germany and in Alsace, but the natural advantages possessed by Wales gave it a commanding position over its competitors. Wales had plenty of coal, iron and water power, and was near the tin mines at Cornwall.

The metal during these early stages of the industry had been reduced into sheet form by hammering, but in 1728 the idea of doing the same work by passing the metal between heavy rolls was conceived, and to those who are familiar with the hot mills in use at the present day it will be readily apparent that this represented an important advance.

Through evolution and invention, several other changes were made from time to time as follows:

In 1770 coal was substituted for charcoal in the manufacture of iron, and it was undoubtedly at this time that the distinction between "Cokes" and "Charcoals" had reference to the base material, but at the present time these trade terms simply refer to the amount of coating.

In 1806 vitriol was substituted for barley water as a pickling solution, and in 1874 a pickling machine did away with hand labor in this department.

In 1829, the annealing pot was invented, which was followed in 1866 by a machine which incorporated the roll feature of the modern tinning machine.

The most important changes which followed were the substitution of Siemens steel for charcoal iron in 1875, and Bessemer steel for puddled bar iron in 1880.

As a result of these various innovations extending over several centuries, we find Wales, in 1890, the only large commercial producer of tin plate, her production being estimated at 13,000,000 base boxes, of which practically 70 per cent was exported to the United States, which at that time produced no tin plate. In 1875 the import duty on tin plate coming into this country was 1.1 cents per pound, and three plants were organized, but a decline in tin plate prices proved their ruin, and it was not until the McKinley Act of October 1, 1890, was passed that any further attempt was made. The McKinley Act became effective July 1, 1891, and provided tariff of 2.2 cents per pound.

This protection was sufficient to allow the American manufacturers, after a period of four years had elapsed, to dominate the market as far as domestic consumption was concerned.

Many new plants were built and competition was keen until in December, 1898, the American Tin Plate Company was formed. This combination included all the existing plants at that time and enjoyed this complete monopoly until 1901.

By a strange coincidence, automatic can-making machinery entered the field about the same time as the manufacture of tin plate commenced in this country. This machinery materially lessened the labor cost for cans, and the improvements in steel making were rapidly reducing the cost and selling price of steel, which forms the principal raw material for tin plate.

These factors were, of course, largely responsible for the steady increase in the consumption and consequent increase in the production of tin plate, which is now used for a multitude of purposes which are familiar to all.

American inventiveness and ingenuity were applied to the manufacture of tin plate to such an extent that the United States has now risen to the position of being the world's largest producer, not only supplying its own demands, but those of a large part of the world also. The production of the tin mills in the United States at the present time is estimated at 36,000,000 base boxes annually.

STATE IRON AND STEEL WORKS IN QUEENSLAND, AUSTRALIA.

In connection with the State Iron and Steel Works which it is the intention of the Queensland government to install at Bowen, a seaport town on the eastern coast of Australia, about 600 miles north of Brisbane, the general manager, J. W. Brophy, accompanied by the engineer for harbors and rivers and the chief inspector of mines for Queensland, have left Brisbane on a tour of inspection of iron lodes in Western Australia, the option on which was secured by the government a short time ago.

These deposits are situated on island contiguous to Yampi Sound on the northwest coast of Australia, and very extensive, and are described by the state mining engineer for Western Australia, as "the richest and most accessible of their kind in the world."

The grade of the ore is 69 per cent metallic and it is estimated that there are nearly 100,000,000 tons available above sea level, while the mining problem presents no difficulties as the ore can be quarried by the inexpensive open cut method and delivered from the bins direct on the ship, the lode running right into the sea, and thereby offering every facility for cheap and efficient handling and shipping.

The Queensland government is considering the recommendation of Mr. Brophy, that they should purchase for this trade, two steamers of the Lake Superior type, this class of vessel being specially built and equipped for the carrying of iron ores, and possessing great tonnage capacities.

It is the intention to blend these with the Queensland ores of 57 per cent metallic, which it is considered will make excellent iron and enable the Queensland State Works to successfully compete with any other iron works either in Australia or elsewhere.

MANGANESE-SILICON ALLOYS IN BASIC OPEN-HEARTH PRACTICE.

The amount of information available on the use of silico-manganese in basic open-hearth practice is meager, but it can be said that silico-manganese can be used and probably with as

PRODUCTION TOPICS

satisfactory results as with ferromanganese and ferrosilicon. Through the coöperation of one steel plant the writer was able to follow two shell-steel heats made with silico-manganese which was added to the ladle. The results of the second of these heats are given here to show what was done. To 11,100 pounds of molten pig iron in the ladle was tapped 122,340 pounds (estimated) of steel analyzing C 0.09 per cent, P 0.12 per cent, Mn 0.15 per cent, S 0.033 per cent, and Si 0.02 per cent. At the same time 1,000 pounds of silico-manganese (50 per cent Mn), 300 pounds of 70 per cent ferro-manganese, 12 pounds of aluminum, and 50 pounds of coal were added to the ladle. The heat was in excellent condition and the ingots had smooth even tops and displayed no superficial action or evolution of gas. The final analysis was C 0.40 per cent, P 0.028 per cent, Mn 0.58 per cent, S 0.041 per cent, and Si 0.21 per cent. This recovery of manganese, assuming the entire loss to come from the alloy added, was 77.5 per cent; the recovery of silicon was 65.1 per cent. Only 24 pounds of carbon or 5 per cent of the total was lost. In the first heat, which was thought to be more highly oxidized, the recovery of silicon was only 58 per cent while the recovery of manganese was only slightly less. These results indicate that silicon protects manganese in "oxidized" heats.

FRENCH IRON PRODUCTION.

(Consul Ernest L. Ives, Paris.)

The total French production of iron ore during the year 1919 is estimated to have been 9,429,689 metric tons (1 metric ton = 2,204.6 pounds). Of this amount, 91.2 per cent, or 8,606,000 tons, was produced in the Lorraine basins, the production of the several producing centers being as follows: Metz-Thionville Basin, 7,127,000 tons; Nancy Basin, 670,000 tons; Longwy Basin, 187,000 tons; Briey Basin, 621,000 tons; a total of 8,606,000 tons.

The difference between the amount produced in the Lorraine basins and the total amount for all France—823,000 tons—was divided among the secondary basins—Brittany, Normandy, and the regions of the Pyrenees.

Labor and Transportation Difficulties.

It is reported that the iron-ore mines were particularly handicapped during 1919 on account of the shortage of labor, the number of workers employed being 60 per cent less than during 1913. The Lorraine basins were especially affected by the shortage of labor, this district employing an important percentage of foreign laborers, who had not returned after the ending of the war.

The stocks in hand at the several mines during the year is given as about 4,200,000 tons. Due to the lack of cars, it was not always possible to transport the ore on hand, which resulted in a slowing down in the production.

The shortage of labor and inadequate transportation facilities also seriously affected the French iron and steel production.

Iron-Ore Production in First Four Months of 1920.

The production of iron ore during the first quarter of 1920 is given as 3,084,115 tons, by months as follows: January, 990,495 tons; February, 974,847 tons; March, 1,118,773 tons. Due to the strikes in April the production fell to 613,028 tons.

French Imports and Exports of Iron Ore.

There were imported into France during 1919, 303,295 tons of iron ore, valued at 22,747,000 francs ($3,1160,27, at 7.20 francs to the dollar, the average rate of exchange for the year).

Countries of origin and amounts were as follows: Belgium, 1,473 metric tons; Spain, 214,983; Italy, 9,113; Algeria, 10,398; other countries, 67,328.

The exports of iron ore during 1919 amounted to 1,697,171 metric tons, valued at 127,288,000 francs ($17,436,712 at the above rate of exchange). The countries of destination are not given, but it is presumed that the majority of the iron ore exported went to Germany.

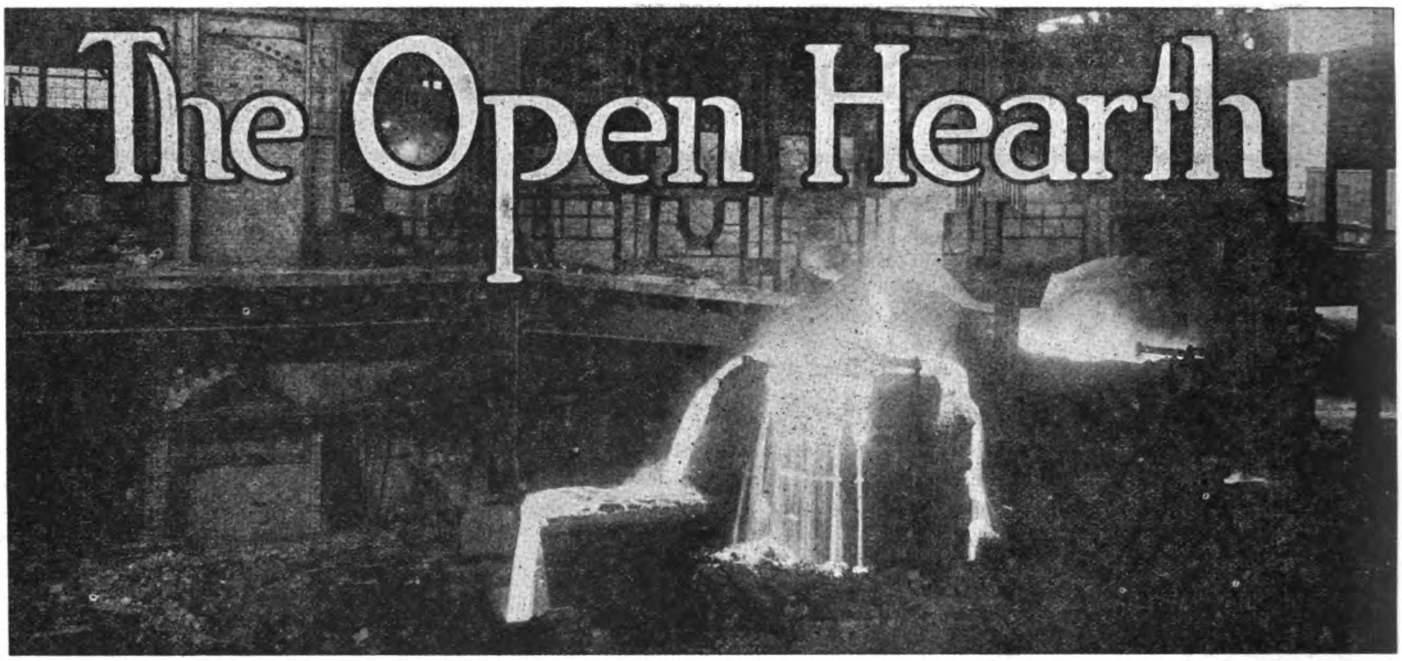
CONNELLSVILLE ELECTRIC STEEL COMPANY SOLD.

The plant of the Connellsville Electric Steel Company at Fayette, along the Yough above Connellsville, has been sold to the Witherow Steel Company, of Pittsburgh, which is getting ready to operate it on an extensive scale. A tract of 25 acres, adjoining the plant, including the old Keystone Tube Mill property, has been purchased, the new owner desiring space for expansion, the ultimate aim being the establishment of an electric steel plant of the first magnitude.

The Witherow Steel Company operates a rolling mill steel property at Neville Island, Pittsburgh. Acquisition of the Connellsville plant marks its entrance into electric steel manufacture and while plans are not quite definite as to the Connellsville operation it will be used in making high grades of steel. As soon as materials can be assembled, the present furnace will be put in operation; another furnace may be added in a few months with others to come in the future. Although the mill has not operated since 1918, the equipment is in very good shape, in fact, almost in condition for immediate resumption.

The plant will be in charge of G. R. Norton, formerly vice president and general manager of the Sizer Forge Company, Buffalo, New York, as steel works manager.

The United States Electrical Steel Company, the original owner of the property, was organized in 1916-1917, a large part of the capital being subscribed in Connellsville and vicinity. The plant was operated until March, 1918, when it was compelled to shut down because of financial difficulties largely due to abnormal wartime conditions. The excessive cost of the plant practically absorbed all of the funds set aside to be used as working capital and the industry never really got away to a fair start. A receivership was forced in 1918, largely by construction debts and the initial cost of raw materials. The property was put up at public sale in October, 1919, and bid in by a group of the original stockholders who realized the possibilities of the industry if taken over by experienced steel interests with adequate financial resources. The company was reorganized as the Connellsville Electric Steel Company to hold the property until a suitable purchaser were secured. All offers that held a possibility of its being removed from Connellsville were rejected.



The Open Hearth

W. H. Geesman has accepted a position with the Lackawanna Steel Company, Buffalo, in charge of the blast furnaces and docks. He was formerly superintendent of the Brier Hill Steel Company, at Youngstown, O.

V V

Thomas Huxley, formerly night superintendent of the blooming mills at Jones & Laughlin's South Side Plant, has been appointed superintendent of No. 12 mill, succeeding George Dutney, who has resigned to accept a position with Johns-Manville Company.

V V

W. S. Quigley, president of the Quigley Furnace Specialties Company, sailed for France on the Cunard liner Imperator, on July 15. His trip is for the purpose of furthering the business relations of the Quigley organization in England, France, Belgium, Italy and Spain.

V V

Edward W. Harry, left the electrical department of the National Tube Company, McKeesport, Saturday, July 17, to accept the position of chief electrical engineer with the Pittsburgh Steel Company at Monessen, Pa. Mr. Harry started with the electrical department in 1910 as a lineman and while in the employ took a course in electrical engineering in Carnegie Institute of Technology, from which place he graduated in 1915. While employed in the department he had a varied experience as lineman, armature winder, meterman, drafting, electrical designing and engineering. Shortly before noon, on July 17, a group picture of the foreman and clerical force was taken, after which a fine traveling bag was presented Mr. Harry.

V V

Fred C. Laughran, superintendent of the bloom yard at Jones & Laughlin's South Side plant has resigned his position, after being with that company for a period of 17 years. It is understood that Mr. Laughran is to become associated with another steel company in the Pittsburgh district in the near future.

V V

Fred A. Bigelow has been elected president of the Carpenter Steel Company, Reading, Pa., to succeed W. B. Kunhardt, who became chairman of the board of directors on July 1. Mr. Bigelow was born in Paxton, Mass., near Worcester, January 31, 1868, and removed to Worcester in 1876. He was graduated from Worcester Polytechnic Institute in 1891 and in 1892 became a chemist for Spaulding & Jennings Co., which later became a part of the Crucible Steel Company of America. In 1900, he was sent to Providence, R. I., as manager of the Providence warehouse and territory for the Crucible company, where he remained until 1904. In that year, he entered the employ of the Carpenter Steel Company, Reading, as salesman in the New England territory and in 1910, he was transferred to the Cleveland warehouse as western sales manager. In May, 1915, he was stationed at Reading as general sales manager.

V V

J. Leonard Replogle, who is president of the Vanadium Corporation of America, and chairman of the Replogle Steel Company, has left for Europe to remain a month or two.

V V

Timothy J. Driscoll, formerly assistant plant engineer of the Pittsburgh Crucible Steel Company's plant at Midland, Pa., has been promoted to plant engineer, succeeding William H. Kent, who recently resigned.

V V

Thomas F. Kelly, formerly connected with the blast furnaces of the Lackawanna Steel Company, has been appointed sales engineer in the flue dust, ore and by-product department of the General Briquetting Company, New York City.

V V

Patrick J. Nestor, who was formerly superintendent of No. 15 mill of Jones & Laughlin's South Side works and later was identified with the Witherow Steel Company, Pittsburgh, has become superintendent of the Peerless Drawn Steel Company, Massillon, O.

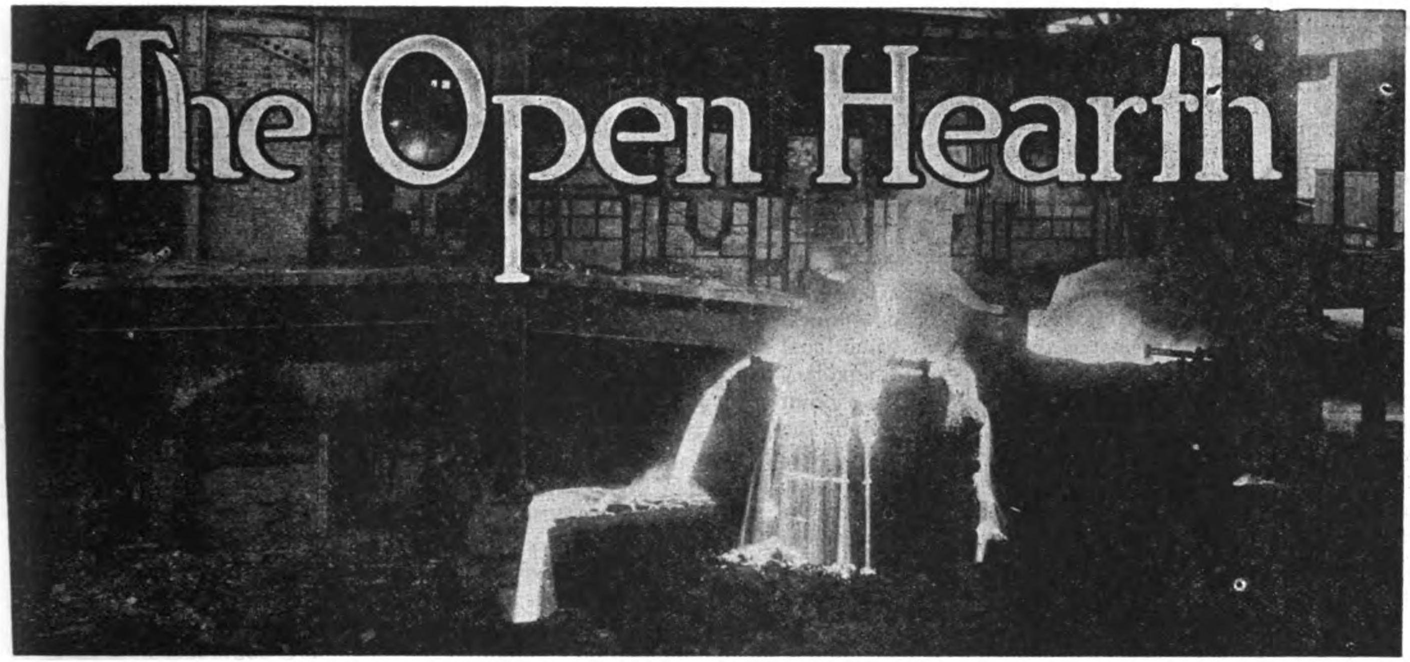
V V

George W. Sargent, who formerly was vice president and metallurgist of the Crucible Steel Company of America, now is president of the Molybdenum Corporation of America, 212 Empire Building, Pittsburgh, which recently acquired the Electric Reduction Company, Washington, Pa., and Questa, N. M. Mr. Sargent's investigations of molybdenum steels were begun in 1899. He will now devote his entire time to the Molybdenum corporation, which owns and operates extensive properties in New Mexico.

V V

W. H. Leech, who for the past few years has had charge of the roll designing for the Witherow Steel Company, Pittsburgh has accepted a similar position with the Peerless Drawn Steel Company, at Massillon, O.

The Open Hearth



T. C. Allen, formerly comptroller of the Tacony Steel Company, has been appointed assistant to the president of the Penn Seaboard Steel Corporation, Philadelphia, Pa.

V V

William H. Lindsay has been elected president of the Napier Iron Works, Nashville, Tenn. Mr. Lindsay has served the same company for the past nine years as executive vice president. Napier Company is one of the oldest of the southern pig iron producers.

V V

E. C. Hummel has been elected president and general manager of the Philadelphia Electric Steel Corporation. Mr. Hummel was formerly superintendent of the Electric Steel Foundry of the United Alloy Steel Corporation, Canton, O.

V V

Harry H. Marsales, formerly traffic manager of the Wickwire Steel Company, Buffalo, has been appointed general traffic manager of the Wickwire Spencer Steel orporation.

V V

Isaac M. Scott, who has been elected president of the Wheeling Steel Corporation, Wheeling, W. Va., which represents the merger of the Wheeling Steel & Iron Co., the Whitaker-Glessner Company, and the La Belle Iron Works, has had a career in the iron and steel business which dates back about 37 years. He was born in Tuscarawas county, O., February 19, 1866, and received his education in the public schools of Morristown, O. In 1883, he began his connection with the iron and steel industry in the shipping department of the Aetna Iron & Nail Co., Bridgeport, O. He continued with this company and its successor, the Aetna-Standard Iron & Steel Co., for 10 years, serving as paymaster, invoice clerk, bookkeeper and assistant secretary. In 1893, he was elected secretary-treasurer of the Beaver Tin Plate Company, Lisbon, O., where he remained for five years and then returned to the Aetna-Standard Company as secretary. When that company was acquired by the American Sheet Steel Company in 1899, Mr. Scott became auditor of the latter company and in 1903, he was elected treasurer of the La Belle Iron Works. In June, 1904, he was elected president of the company and in August, 1912, he assumed active direction of the Wheeling Steel & Tin Plate Co., Wheeling. Later he was elected president of the latter company. On July 17, 1914, when the Wheeling Sheet & Tin Plate Co. was merged with the Wheeling Steel & Iron Co., Mr. Scott became president of the latter company, succeeding C. R. Hubbard, who was made chairman of the board.

V V

C. J. Steen, chief engineer of the Tacony Steel Company, has been appointed chief engineer of the Penn Seaboard Steel Corporation.

V V

H. A. Bishop, formerly New York manager of the Petroleum Iron Works Company, Sharon, Pa., has been elected vice president in charge of sales and will hereafter be located at Sharon. G. E. Mittinger, formerly manager of the pressed steel products department, has been elected vice president in charge of production.

V V

James Bryden, who is works manager of Smith & McLean, Ltd., Glasgow, Scotland, sailed from New York after a two months visit through the steel plants in this country.

V V

H. F. Noyes, H. G. Darling and E. Lewis of the Broken Hill Proprietary Company of Australia, are spending some time in this country visiting steel plants. Mr. Noyes is superintendent of the blast furnaces; Mr. Darling is one of the directors and Mr. Lewis is assistant to the general manager of the company. Their purpose of this visit is to secure some information regarding blast furnaces, as the Broken Hill Company contemplate building two additional blast furnaces in the near future.

V V

H. F. Prescott has been appointed works manager of the C. D. Pruden Corporation, Baltimore, a subsidiary of the Blaw-Knox Company. Mr. Prescott was formerly chief draftsman of the Blaw-Knox Company.

V V

Arthur S. Booth has been appointed assistant general manager of sales of the Sharon Steel Hoop Company, with headquarters at Sharon, Pa., effective July 15. R. C. Garlick, formerly district sales manager at Cleveland, will succeed Mr. Booth as manager of the Chicago branch. Thomas Galbreath of the general sales office force has been named manager of the Philadelphia office. B. F. Kibbee is general manager of sales.

V V

George W. Peffer has been appointed general superintendent of the Sharon Steel Hoop Company, Sharon, Pa., succeeding Noble Jones, who has resigned. Mr. Peffer was formerly superintendent of the Lansingville plant of the Republic Iron & Steel Co.

NEWS OF THE PLANTS

The Chicago Rolling Mills, Inc., Chicago, Ill., recently organized by officials of the Sessions Engineering Company, Chicago, has acquired the plant formerly occupied by the Chicago Electric Steel Company for its proposed new works. It is proposed to install considerable additional equipment, including rolling mill machinery and auxiliary operating apparatus, to bring the plant output up to a point of about 3,000 tons of material a month. Included in the installation will be continuous billet heating furnaces, five-stand, 10-inch merchant mill, with roughing mill, yard magnet cranes, etc. P. W. Chapman, Chicago, is president of the new organization, and E. O. Sessions is vice president in charge of operations. It is planned to have the works ready for production before the close of the summer.

The American Iron & Steel Corporation, Engineers' Building, Cleveland, O., recently organized under Delaware laws with capital of $50,000,000, is planning for the erection of a new plant in the vicinity of Michigan City, Ind. The company has secured a site at this place with frontage on Lake Michigan, and proposes to build a large steel works, including blast furnace, open hearth furnaces and sheet mill. At a later date, the initial buildings will be augmented with a new tube mill and a number of finishing mills. The company will operate as a subsidiary of the Lake Superior Iron Ore Company, Cleveland, which was organized not very long ago to develop iron ore properties in Canada and other localities. The new organization will derive its raw materials from this source, and plans to build a number of vessels, with capacity of about 12,000 tons for transportation of ores to the plant. The American Iron & Steel Company is headed by F. W. Wheeler, president of the Saginaw Shipbuilding Company, Saginaw, Mich.; L. L. Knox and E. E. Slick, heads of the Slick-Knox Company, Pittsburgh, Pa.

The Carolina Steel & Iron Company, Greensboro, N. C., has perfected plans for the erection of an addition to its plant for increased production. The new building will be about 75x225 feet, and will be equipped with punches, shears, angle shears, bending rolls, etc. The extension is estimated to cost in excess of $35,000. Following this installation, it is planned to install other new equipment in different parts of the plant. J. W. McLennon is secretary and treasurer.

The Witherow Steel Company, Pittsburgh, Pa., is planning for extensive additions in operations for large increase production. At its plant on Neville Island, the company will install new rolling mill equipment, and this plant in the future will be operated in conjunction with a new works at Connellsville, Pa., comprising the former plant of the United States Electric Steel Company, as well as the plant of the Keystone Tube Works, located on an adjoining site. The first noted plant has been in operation but a short time, as the United States Electric Steel Company was started during the war period; since the signing of the armistice the works have been idle. The new owner plans for the installation of additional equipment, to include a blooming mill, hammer equipment and other machinery, and will use the works for the production of electric steel specialties, including special and alloy steels. It is said that at a later date a department of the plant will be devoted to the manufacture of tool steel products.

The American Car & Foundry Company, Clinton and Babcock streets, Buffalo, N. Y., has construction under way on a program for expansion and improvements in its local plant to cost about $1,000,000. The company has recently secured property adjoining its plant and upon which some of the new buildings will be located. The additions will include an erection shop, 95x620 feet; general iron working building, 40x110 feet; a new shop for the manufacture of railway car trucks; forge and blacksmith shop; boiler plant and general power house for works service. Facilities will be provided for a large increase in the present working force. It is planned to have the majority of the buildings ready for the installation of machinery and occupancy early in October. The construction contract has been secured by the J. W. Cowper Company, Fidelity Building, Buffalo.

The Jamestown Malleable Products Corporation, Jamestown, N. Y., has plans under way for the erection of a new plant at Falconer, N. Y., for the manufacture of iron and steel products. The new works will be 400x400 feet, and is estimated to cost about $300,000, including machinery and other operating equipment.

The Western Rolling Mills Corporation, Seattle, Washington, has perfected arrangements for the erection of the initial units of its proposed new steel plant to be located on a site near the southern limits of the city, recently purchased. The property totals over 60 acres, and only a portion of the tract will be utilized for the first buildings. These will include an electric furnace and open hearth furnace, with three mill buildings, 85x540 feet; there will be two smaller adjoining structures, 50x240 feet and 40x250 feet, respectively. The initial plant unit will have a capacity of about 75 tons of material per day and will be equipped to give employment to about 300 men. The majority of the machinery will be of electric-driven type. This portion of this plant is estimated to cost close to $1,000,000, while the completed works will represent an investment in excess of $10,000,000. The units to be erected at a later date will bring the capacity up to about 300 to 400 tons of material per day. and will comprise merchant bar rolling mill, open hearth furnaces, ingot continuous furnaces, furnace for continuous billet work, breakdown mill, 12-inch merchant mill, electric furnace equipment, with a number of auxiliary operating buildings, such as machine shop, forge shop. A large allotment of handling apparatus will be installed, including cranes, electric conveyors, etc. The complete plant will include, as well, a number of blast furnaces, to be located at iron ore properties of the company, near Bellingham, Wash. The deposits are estimated to contain over 100,000,000 tons of hematite ore, and will be supplemented by the working of other properties controlled by the organization in British Columbia. The new plant has an ideal situation, allowing both rail and water facilities. The company has established offices in the Pacific Block, and is headed by J. Johnson, president, formerly connected with the Riga Iron Works, Riga, Russia; J. M. Price, vice president, and Frederick Bruhn, secretary and treasurer.

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Some Pointers on By-Product Coke Oven Operations

THE MANUFACTURE OF COKE.

By J. E. Landt of Semet-Solvay Company.

Closely allied with the steel industry in its many various forms, is the coke industry. In the present day, practically all of the iron made and used in this country comes directly or indirectly from processes involving the use of coke as a fuel.

During the 18th century coke made its appearance in England due to the growing scarcity of charcoal and since that time has made rapid strides in replacing other forms of fuel for the smelting of iron.

The first coke made was produced from the so-called beehive ovens. The beehive oven of more modern type is a dome shaped affair built of bricks, about 12 feet square and in the crown is a hole about 15 inches in diameter to emit gases and through which the coal is charged. The charge of coal, about five tons, is dropped in from the top, leveled and the door bricked up to within an inch of the top. This space is left for an air inlet.

Gases arising from the coal burn and heat up the chamber of the oven and the distillation of the coal continues progressively from top to bottom of the mass. The air admitted during the coking process should not exceed that necessary to burn the gas, otherwise the carbon will be attacked and cause a low coke yield. The coal in the beehive ovens lies in a bed about 23 inches to 27 inches deep. After 48 hours the oven is opened and water thrown in on the hot coke which causes it to practically break up. The coke is then drawn out through the door and further quenched and cooled outside of the oven. The oven is then ready for another charge. For making better grades of coke, such as foundry coke, 72 hours is allowed.

Coke is the product or solid residue resulting from the distillation of bituminous coal. It can only be made from what are known as "coking" coals. Coking is not a universal property of all bituminous coals and great care must be taken in the selection of coals used if a good coke is to be the result. Sometimes a small amount of non-coking coal is mixed with a good coking coal and satisfactory coke is produced.

The process of coking, itself, consists in driving off at high temperatures all the volatile matter or gaseous parts of the coal, leaving as a residue, carbon, ash, sulphur and some phosphorus. Some of the carbon, sulphur and phosphorus may be driven off in the gases but not all. Ash, sulphur and phosphorus constitute the chief impurities in coke. The analysis of a good coking coal and the resulting coke will run about as follows:

Volatile matter	30%	1 %
Fixed carbon	61%	86.2%
Ash	8%	12 %
Sulphur	1%	0.8%
Phosphorus	Trace	Trace

We now come to a discussion of the by-product coke oven. The process of making coke or distilling coal in the by-product oven differs from that of making coke in the beehive oven in that no air is admitted to the coking chamber and the gases are collected and used instead of being allowed to burn up. As the name signifies, the by-product oven produces coke as the main product, with gas, tar, light oils, ammonia and cyanide as by-products.

There are many and various designs or types of by-product ovens, which usually consist of a horizontal chamber from 30 to 40 feet long, from 12 inches to 21 inches in width and from 6 to 15 feet in height. The chambers are heated by various systems of flues which surround it, and it is in this manner principally that the various by-product ovens differ as well as in the type and style of construction. A series of ovens built in a row is known as a battery or block of ovens, the size of which depends upon the amount of product desired.

The ovens on the "Hill" are designated as 6-36-19½ Semet-Solvay regenerator ovens, which means that they are 6 flues high, 36 feet in length and 19½ inches in width. These ovens will carry a charge of about 16 dry tons of coal each. The coking time will vary from 16 to 24 hours depending upon the amounts of coke it is desired to produce.

Coals from the Pennsylvania region are used chiefly, and are unloaded at a preparing or mixing station. The coal first passes through a rough roll crusher where the large lumps are broken up, and from there to a pulverizing machine where it is ground much finer. The coals can also be mixed at this point if desired. The coal is stored in a large bin of about 1,000 tons capacity from which it is loaded into the charging car, or charging larry. This car runs out over the ovens and drops the coal through suitable holes into the oven chamber. The coal is then leveled in the oven which is closed up as tight as possible with luting clay around the cracks in the doors, etc. The gas arising from the coal is taken off the top of the oven into a large steel header known as the hydraulic main. Just as the gas enters the main it receives a cooling to reduce the temperature. A portion of the tar and some ammonia falls out here. The gas passes through what is known as a primary cooler, where it is further cooled and then to the exhauster or pumping engines. From the engines the gas passes through tar extractors where the last portions of the tar are removed and then into the ammonia scrubber when the gas is washed with clean, cool water. The gas then passes to another scrubber where the so-called light oils are removed and then into a cyanide scrubber. After leaving the last scrubber the gas is divided, about 40 per cent going back to heat the oven chamber and about 60 per cent into the surplus gas line through which it is sent to the Wickwire plant for use in the mills and boilers.

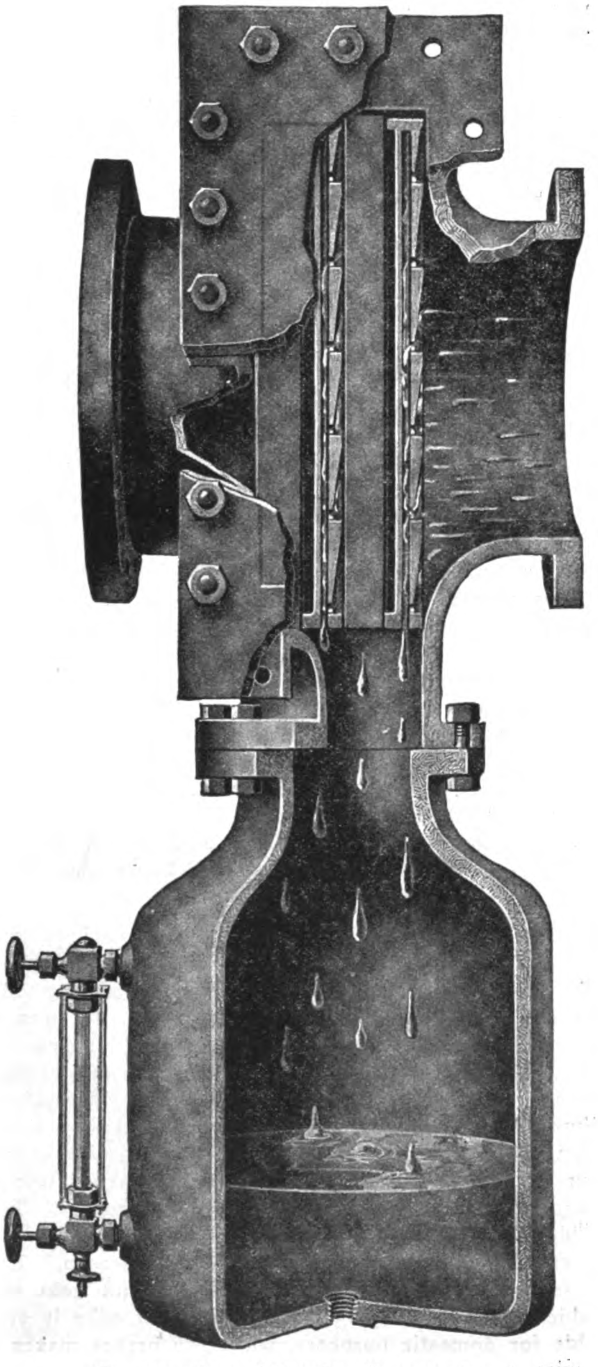
When the coking period is over, a machine known as the pusher is spotted before the oven, the doors raised, and the pusher-ram, about 40 feet in length, is inserted in the oven. The coke is pushed from the rear of the oven through a coke guide into a car known as the quenching car. This car is then placed under sprays of water at the quenching station until all traces of fire have been removed. The coke is then dumped on a wharf from which it is taken by a conveyor belt to the screening station. The coke passing over a riffle screen with 1¼ inches openings, is discharged into railway cars ready for shipment to the blast furnaces. The coke which falls through the 1¼ inch screen, is again screened over a ¾ inch square opening shaker screen. The coke passing over this screen is known as nut coke and that which passes through it as breeze. Nut coke is very suitable for domestic purposes, while the breeze makes a good boiler fuel.

WITH THE EQUIPMENT MANUFACTURERS

BUNDY OIL SEPARATOR—STILL AT IT.

The Bundy Oil Separator is known to engineers throughout the world and it is a remarkable fact that in spite of the years which have elapsed since this apparatus was designed it is still holding its own.

The accompanying cut shows clearly the construction of this separator. Shell and baffle plates are of cast iron. These multiple baffle plates are of special staggered grid construction and are so designed as to insure the removal of all oil from the exhaust steam before it leaves the separator. The oil after being deposited on the saw-tooth grids, enters a duct inside of the grid bars and flows through this duct to the large receiver reservoir at the bottom. This feature prevents steam from picking up the oil again after it has been deposited on the baffle plate.



Construction of Bundy oil separator.

This separator fulfills one of the most important requirements of an efficient oil separator. It is apparent that if an oil separator is efficient that the separation cannot be accomplished without the baffle plate surfaces becoming gummed with oil and grease and also that this coating reduces the separating efficiency. It is, therefore essential that an oil separator be so constructed as to be easily cleaned. The bafflle plates in the Bundy Separator are removable through an opening provided and may be taken out and cleaned in a lye solution and returned to the separator ready for another period of efficient service.

The Bundy Oil Separator is manufactured by the Griscom-Russell Company, 90 West street, New York, and is described in their new bulletin No. 1130.

THE MILLER MECHANICAL GAS PRODUCER.

The W. R. Miller Company, of Pittsburgh, Pa., have produced a new gas producer which is now being advertised under the name of the Miller mechanical gas producer.

This producer embodies many new and advantageous features. The principal blast distributor is located on the exterior, and the small grate sections are of easy access through the sealed doors on the outside of the wind box, which is stationary. The blast is supplied by four blowers.

The grate sections have a blank space in each to prevent the blast from the blowers cutting channels through the interior.

These grate sections are the same as used in hand poked producer, and do not require replacement in from 5 to 11 years, being protected by the blast.

The small distributor in the interior of the producer, in the event of clogging or burning out, can be replaced in a short time and at a convenient period, as the blast from the exterior will permit the operation of the producer until replacement can be made without interruption to the continuous operation of the plant.

The ash and clinker have free fall to the ash pan, there being no obstruction to prevent same. The ashes are removed from the water-sealed revolving ash pan by the lowering of a stationary shovel; the ash is then discharged into a car or bucket or onto a conveyor.

The free discharge of the ash permits the regular lowering of the fuel bed without the breaking up of same, which would cause the forming of rivers or channels through which the hot gases would escape.

This producer has a double fuel feed and is so designed to prevent the gases from escaping through same, and it operates automatically, thus regulating the amount of fuel going into the producer.

A rotary wall cleaner is another important feature which is intended to keep the walls of the producer free from clinker. This wall cleaner is water-cooled and rotates within itself, in close proximity to the revolving walls of the producer.

This producer embodies all the principal features of the leading mechanical machines now offered to the trade, with the added advantages above briefly described and is the last word in gas producers.

WITH THE EQUIPMENT MANUFACTURERS

4810 AIR HOSE.

One of the most expensive operations necessary in a steel plant is the chipping of steel, and every effort is being made by large steel companies to secure equipment for chipping purposes, which will reduce the cost to the lowest possible point. Many of the large plants for this reason have adopted the "4810 Air Hose," made by the United States Rubber Company. "4810 Air Hose" has proven to be the most economical air hose manufactured. This fact is also recognized by operators of ship yards, quarries, mines, machine shops, structural steel builders, and all classes of industries requiring the most efficient labor and machinery. Five reasons given for its success are as follows:

1. Economical—extra life proportionately greater than hose of lower initial cost.
2. Heavy tough cover makes wire unnecessary.
3. Extra strong and stands a great bursting pressure.
4. Braided construction which prevents kinking and produces flexability.
5. Oil proof as the tube does not deteriorate when oil comes in contact with it.

RECENT THOMAS METER INSTALLATIONS FOR MEASURING NATURAL GAS.

Interesting among the recent installations of the Thomas Meter is one for measuring natural gas at the American Rolling Mill Company, Middletown, O.

The gas pressure varies from 5 to 50 pounds and the temperature from 35 to 75° F. These variations are, however, automatically cared for by the Thomas Meter, and the graphic chart gives the results directly in cubic feet of gas at 14.9-60.

The gas is supplied by the Ohio Fuel & Supply Co. of Columbus. The housing of the 400.000 cubic feet per hour Thomas Meter, is located together with the recording instruments, in a small brick building. The 16 inch meter housing is placed in an 8 inch steel pipe line like a length of pipe. Readings are taken each morning to check the total amount of gas used for the previous 24 hours, while the demand current for that period is automatically charted by the graphic instrument.

A Thomas Meter recently installed at the Citizens Light, Heat & Power Co. at Lawrence, Kan., also measures natural gas in standard cubic feet with no corrections necessary for pressure, temperature, gravity or composition. The meter housing in this case is located in a small building at the edge of the corporate limits of the city, for the purpose of checking the orifice meters of the supply company. The gas is billed by the orifice meter readings, but the Thomas Meter gives the purchasing company a check and settles any controversy between the purchaser and seller, and any discrepancies are immediately noticed and remedied. The basis formerly used was to bill a given percentage of the total of the consumer's meter readings, and therefore, any gas lost by leakage in the city pipe lines was not recorded, and the supply company was the loser. On the other hand, the purchasing company refused to accept the readings of the orifice meters, because the results were obtained in the form of differential pressures from which the gas quantities had to be computed. By the new arrangement, the Thomas Meter measurements are made directly in standard cubic feet of gas per hour and the measurements are made at the city limits. The controversies which used to occur between the supply and purchasing companies, are now eliminated.

DUQUESNE LIGHT COMPANY ORDERS ANOTHER 60,000 KW UNIT.

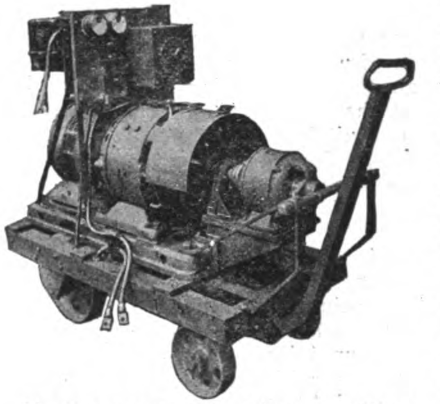
So great has been the demand for electric energy by various industries of the Pittsburgh district that the Duquesne Light Company has been compelled to arrange for the doubling of the proposed initial installation of 60,000 kw at its new Colfax power plant. The second 60,000 kw turbine generator with 100,000 square feet surface condensers divided in four shells, which has just been ordered from the Westinghouse Electric & Manufacturing Co., will be a duplicate of the first machine. It will be designed to operate at maximum efficiency when subjected to a load of 50.000 kw, and to take care of a maximum load of 70,000 kw for short periods.

Steam will be supplied to the turbine at 275 pounds pressure, 175 degrees F. superheat and 29 inch vacuum.

In addition to the equipment mentioned a 2,000 kw ac house turbine has been ordered to furnish energy for the plant auxiliaries.

SINGLE-OPERATOR ELECTRIC-WELDING OUTFIT.

The single-operator electric arc-welding equipment manufactured by the Westinghouse Electric & Manufacturing Co., is claimed to be exceptionally efficient because the generator operates at arc voltage and no resistance is used in circuit with the arc. The generator is designed to inherently stabilize the arc, thereby eliminating the necessity for providing automatic moving devices such as relays, solenoid control resistors, etc. which not only increases the cost of investment and maintenance, but may not be quick enough in action to follow the instantaneous changes of the arc circuit.



Single operator electric arc-welding equipment.

The generator of the set has a rated capacity of 175 amperes, is of standard design and construction, provided with commutating poles and an exceptionally long commutator which enables it to carry the momentary overload at the instant of striking the arc without special overload protection.

The design of the control is such that very close adjustment of current may be easily and quickly made, and once made, the amount of current at the weld will remain fixed within close limits until changed by the operator. There are 21 steps provided from 50 to 225 amperes. This gives a current regulation of less than 9 amperes per step which makes it much easier for a welder to do vertical or overhead work often encountered in railroad shops and ship construction.

TRADE NOTES

Dewitt Clinton Grove, past vice president of the Technical Publicity Association, has become advertising manager of the Blaw-Knox Company, of Pittsburgh, manufacturers of Blaw buckets, Blawforms for concrete construction, Prudential steel buildings, Knox water-cooled doors and ports, transmission towers, and structural and plate steel products. Mr. Grove succeeds George Land, who resigned July 1, to enter the agency field as head of the Technical Publicity Company, of Pittsburgh.

Another new man in the Blaw-Knox advertising department is Leo Robin, a former newspaper editor of Pittsburgh, who in connection with other duties is editing "Blaw-Knox Life," the company's house organ.

At a recent meeting of the Stoker Manufacturers Association, held at Lakewood, N. J., the following officers and executive committee were appointed: Sanford Riley, president; M. Alpern, vice president; A. G. Pratt, treasurer; S. A. Armstrong, and H. A. Hatton; J. G. Worker, secretary. This committee is to meet in New York at an early date to name the standing committees of the organization for the coming year. A vote of appreciation and a round of cheers was tendered to P. A. Poppenhusen, the retiring president.

The Chicago Rolling Mills, Inc., have taken over the plant previously occupied and equipped by the Chicago Electric Steel Company. The plant will be rehabilitated and operated under the supervision of the Sessions Engineering Company. The office of the plant management is 1203 Majestic building, Chicago. P. W. Chapman, of New York and Chicago, is the president of the new company. Other members of the organization are as follows: E. O. Sessions, vice president, in charge of operations; R. J. Caudy, general manager; T. C. Hicks, superintendent of Kensington Rolling Mill. With the additional rolling machinery now being procured for installation, the plant will have a rolling capacity of approximately 3,000 tons per month. The plant equipment will include magnet yard cranes, continuous billet heating furnaces and a Belgian mill combination consisting of motor driven roughing mill and a motor driven 5-stand 10-inch merchant mill. The mill still has capacity available for conversion, and it is expected that production will start during August.

Rapid progress is being made on the erection of the coal pulverizing plant at the Mt. Vernon street station of the Philadelphia Rapid Transit Company.

This plant, which is at present equipped with twenty 375 hp Babcock & Wilcox water tube boilers and has been producing about 75,000 kw hours of electric energy, using river and buckwheat anthracite coal.

The needed output of the plant will be obtained with but 10 boilers, using powdered coal, as compared with the 20 formerly required for hand firing.

The fuel, after being dried and pulverized, is to be transported through four inch pipes to a sub-divided, totally enclosed bunker, located between the banks of the boilers. From this bunker, it will be fed in controllable quantity into specially designed combustion chambers where the required air for combustion also under close control will be added. In the coal milling plant a blow tank unit of five tons per charge capacity equipped with a quick reading scale is now in the course of erection. By compressed air the fuel is delivered to the bunker and correct fuel records obtained for each boiler. Switching valves appropriately located along the fuel distribution line will deliver the coal to any desired section of the bunker.

Three thousand pounds of coal per hour is the capacity of the feeding and burning equipment of each boiler.

It is expected that the first of the boilers will be in operation during September.

The entire equipment is being furnished by the Quigley Furnace Specialties Company, 26 Cortlandt street, New York City, and erected under the supervision of their engineers.

"Blawnox" is the new name conferred by the United States Senate upon the town of Hoboken, Pa., the home of Blaw-Knox Company, manufacturers of Blaw buckets, Blawforms concrete construction, Knox water-cooled doors and ports, Prudential steel buildings, transmission towers, and other structural and plate steel products.

About 1,000 persons are employed in the Blaw-Knox shops, most of whom live in old Hoboken. A petition signed by the people of the town, asking the Senate to change the postoffice name to Blawnox has just been granted.

The Skinner & Eddy Shipbuilding plant of Seattle, Wash., on June 21, passed into the hands of the Barde Industrial Corporation which is an allied firm of the Barde Steel Products Company, of New York City, for a consideration close to $1,500,000. The deal was consummated by L. B. Barde, managing director, and M. Barde, head of the pioneer firm of M. Barde & Sons, of Portland, Ore. David Skinner and Henry Seaborn represented the Skinner & Eddy Co.

Oxweld Wins Distinguished Service Award.

The Oxweld Acetylene Company, of Newark, N. J., Chicago and San Francisco, is justly proud of the distinguished service award tendered the company by the War Department of the United States. The award reads: "The War Department of the United States recognizes in this award for distinguished service the loyalty, energy and efficiency in the performance of the war work by which the Oxweld Acetylene Company aided materially in obtaining victory for the arms of the United States of America in the war with the Imperial German Government and the Royal Austria-Hungarian Government." The award is signed by the Secretary of War and the assistant secretary of war, director of munitions. The Oxweld Company has used the award with effect recently in its advertising under the caption, "Another O. K. on a Good Product."

TRADE PUBLICATIONS

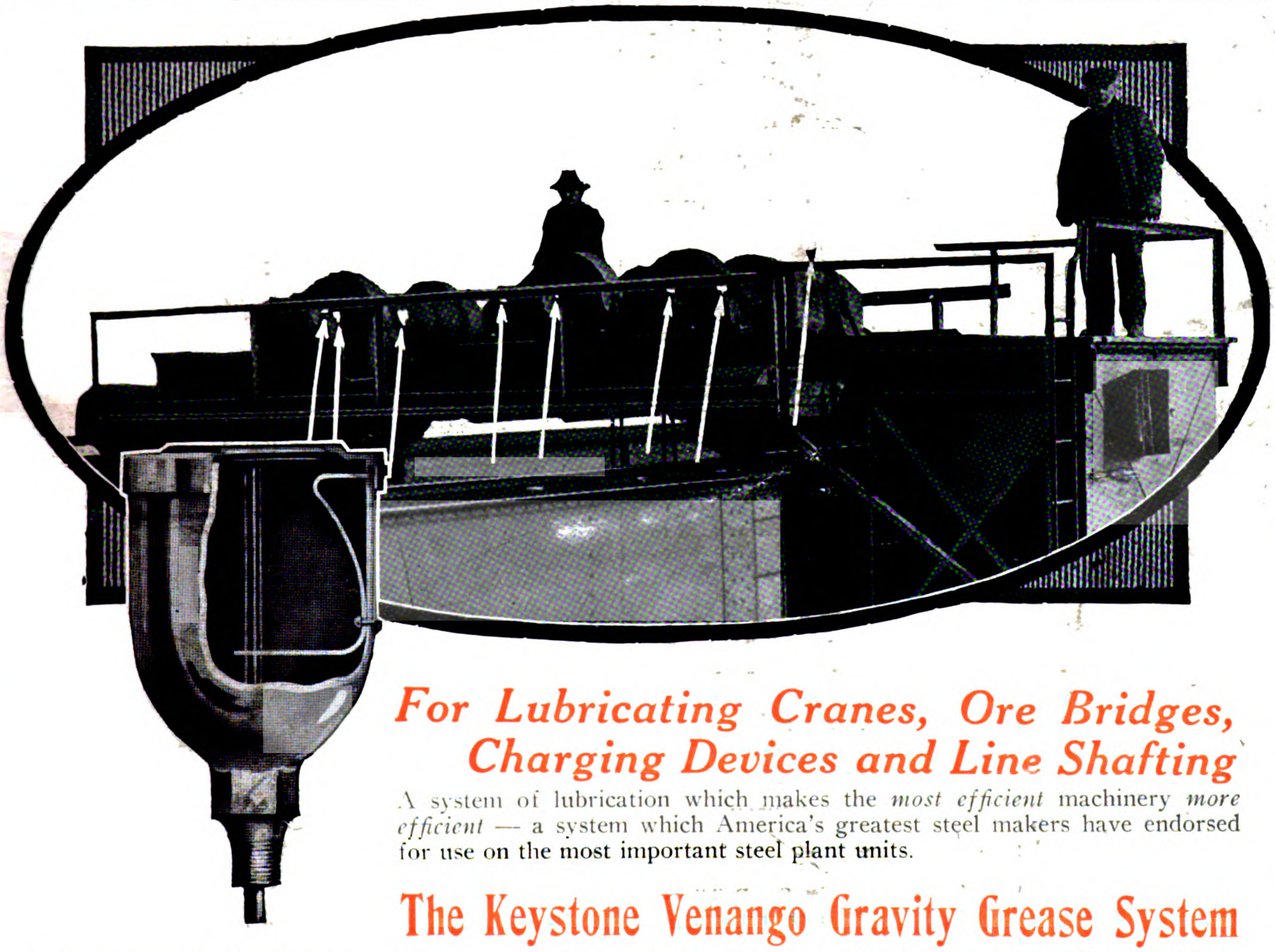
"C-H Lifting Magnets" is the title of a new 8-page, 8½x11 pamphlet published by the Cutler-Hammer Manufacturing Company., Milwaukee, Wis., and describing their circular type of lifting magnets. This pamphlet, known as Publication 855, tells how many iron foundries, steel mills shipyards, and other plants all over the country are speeding up their production, wiping out demurrage charges, reducing handling costs, and solving the labor problem, by using C-H lifting magnets for handling pig iron, scrap, castings, rails, etc. Several specific examples are given to illustrate how C-H magnets have reduced the time required for loading and unloading cars, and how one manufacturer saved $180 per month in handling a small tonnage of scrap by means of a C-H magnet. The construction of C-H circular magnets is briefly dwelt upon, and reference made to the sturdy steel casting and water proof construction, with illustrations. Several views of C-H magnets are shown handling scrap, pig iron, skull cracker ball, and other material. A table lists the C-H circular magnets from the 5-inch up to the 62-inch size, with their net weights, dimensions, current requirements, lifting capacities, and the This pamphlet replaces the former pub- material for which they are best adapted. lication known as Bulletin 12.

The Metal & Thermit Corporation, New York, N. Y., has just issued and will distribute on request the third edition of its Thermit Pipe Welding Pamphlet No. 16. In this new edition the subject of Thermit pipe welding has been revised and brought up to date. The new pamphlet describes and illustrates in detail how Thermit pipe welds are made and contains reports on successful tensile strength and vibration tests of Thermit pipe welds conducted by Stevens Institute. One of the features of the new pamphlet not previously published in former editions is a chart showing the comparatively low cost of a Thermit welded pipe as compared with the cost of installing compression flanges with bolts and gaskets, and of installing elbows with flanged connections. The new edition also contanis for the first time an account of a 10-year pipe test at West Albany, N. Y.

Member of the Audit Bureau of Circulations.

The Blast Furnace and Steel Plant

Pittsburgh, August, 1920.



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